Race 19. Ear lax, awn short, empty glume pubescent and brown, seed brown. This race can be referred to as var. ***subbarbarossa-inflatum*** PALM. from Mongolia. This race was found abundantly in the suburbs of Maimana and Tehran. The strains with a squarhead ear were found in the Tehran region, namely Nos. 3215–1, 3217–10, 3220–7, 3374–1 and 3231–10. However, a new type with yellow instead of brown seed was found in the Tehran and Isfahan regions, especially in the suburbs of Firuzkuh in the Tehran region (Fig. 40b, c, d).

a b c d

Fig. 40. *T. vulgare*

a. var. *echinodes-inflatum*-like (*nova*), with a lax ear. (No. 3214–1),
b. var. *subbarbarossa-inflatum* (No. 3133 – 10),

This race can be referred to as var. *submeridional-inflatum* PALM. from Mongolia. This variety was found in Kandahar - Kabul (Fig. 41b).

Race 22. Ear lax, awn short, empty glume glabrous and brown, seed brown.

This race can be referred to as var. *subferrugineum-inflatum* PALM. from Mongolia. This variety was found in the Tehran and Isfahan regions (Fig. 41c).

Race 23. Ear lax, awn short awned ear, empty glume glabrous and brown, seed yellow.

This race can be referred to as var. *suberythroleucon-inflatum* FRENK. from Tova. This variety was found only in Shahrud in the Tehran region (Fig. 41d).

Race 24. Ear lax, awn short, empty glume glabrous and yellow, grains brown.

This race can be referred to as var. *suberythrospermum-inflatum* PALM. from Mongolia. This variety was found in the Tehran and Isfahan regions (Fig. 41e).

Race 25. Ear lax, awnless, empty glume pubescent and brown, seed brown or yellow.

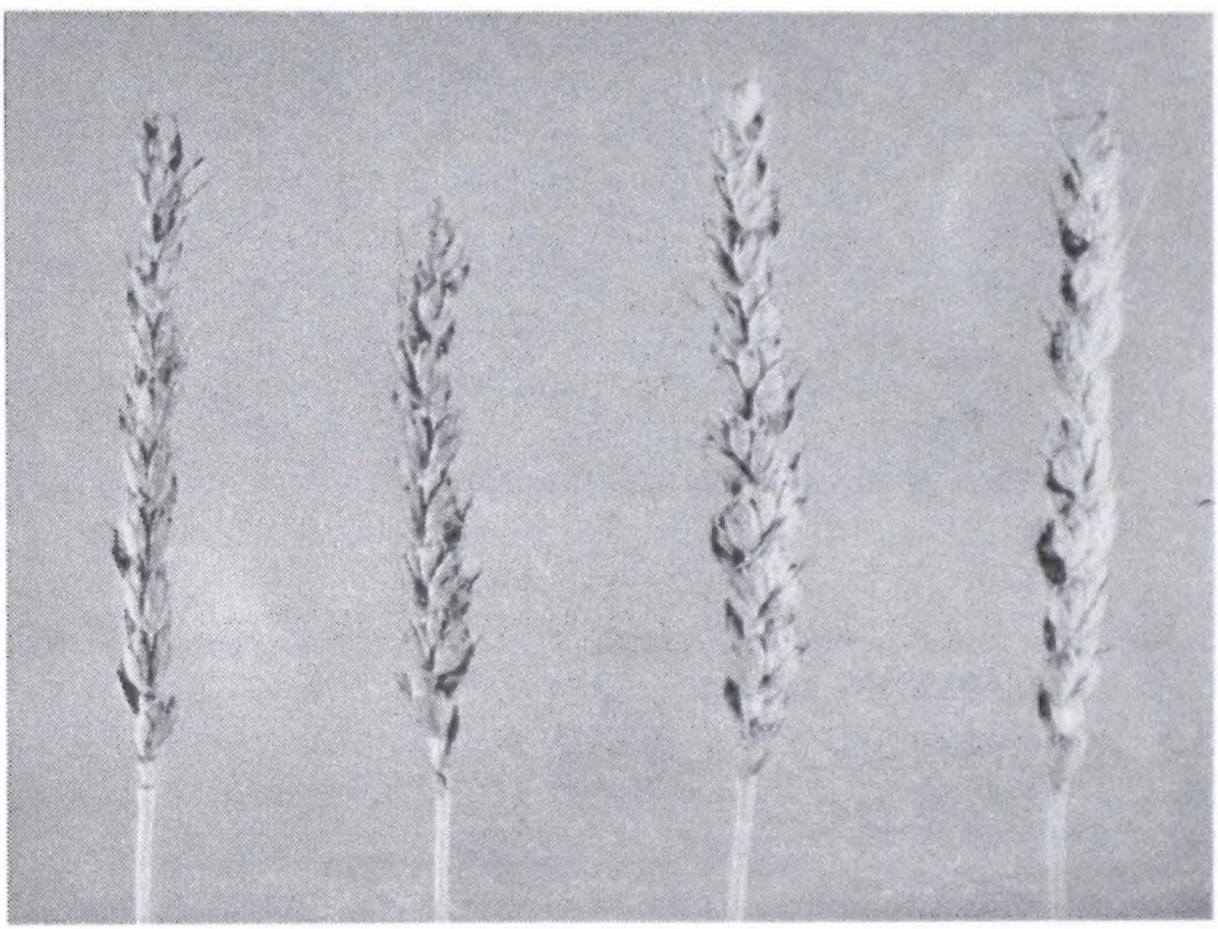
a) The type with brown seed can be referred to as var. ***turcomanicum*** Kob. from Turkmenistan. This variety was found in the Isfahan region (Fig. 42a).

b) The type with yellow seed can be referred to as var. ***transcaspicum*** Vav. from Transcaspian and other districts. This variety was found in the suburbs of Tehran (Fig. 42b).

Race 26. Ear lax, awnless, empty glume pubescent and yellow, seed brown or yellow.

a) The type with brown seed can be referred to var. ***heraticum*** Kob. (=var. ***velutinum-inflatum***) from Turkestan, Afghanistan, China, Mongolia and others. This variety was found only in one habitat in the Isfahan region (Fig. 42c).

b) The type with yellow seed can be referred to var. ***khorassanicum*** Vav. from Iran. This variety was found abundantly in the Isfahan region (Fig. 42d).



a b c d

Fig. 42. *T. vulgare*

a. var. ***turcomanicum*** (No. 3188-1), b. var. ***transcaspicum*** (No. 3284-1), c. var. ***heraticum*** (No. 3210-8), d. var. ***khorassanicum*** (No. 3192-1)

Quetta and in four habitats in the Isfahan region (Fig. 43b).

b) The type with yellow seed can be referred to as var. ***albinflatum*** VAV. from Asia. This variety was found in two habitats in the Isfahan region (Fig. 43c).

a b c

Fig. 43. *T. vulgare*

a. var. ***alborubrum-inflatum*** (No. 3286–1), b. var. ***lutinflatum*** (No. 3172–5), c. var. ***albinflatum*** (No. 3189–4)

d. *T. compactum* HOST

T. compactum varieties were found mainly in the mountainous areas in the Kabul and Pahlavi regions (Fig. 44). All the strains collected in those regions can be referred to as var. ***erinaceum*** KÖRN. from Asia Minor, Armenia, Transcaucasia, Afghanistan, Turkestan and China. However, the Afghan strains were

a b c d

Fig. 44. *T. compactum erinaceum*

Afghan type:
a. No. 3098–9, b. No. 3100–13

Iranian type:
c. No. 3306–2, d. No. 3308–4

The strains with dense ear predominated in the district around Ardabil. The strains with long brown ear can be referred to as *T. vulgare* var. *ferrugineum-compactoides* Kob., while the strains with long yellow ear can be referred to as *T. vulgare* var. *erythrospermum-compactoides* Kob..

2. Tetraploid species

a. *T. durum* Desf.

T. durum varieties were found in the Tehran and Gorgan regions, namely,

Fig. 45. *T. durum*

a. var. *hordeiforme* (No. 3233–8), b. var. *obscurum* (No. 3249–3), c. var. *murciense* (No. 3256–1), d. var. *valenciae* (No. 3270–2), e. var. *provinciale* (No. 3291–1)

Var. *valenciae* KÖRN. (Nos. 3270–2, 3271–8). 40 km N. E. of Tehran (Tehran-Furuzkuh). Awn long, empty glume pubscent and yellow, seed yellow.

Var. *provinciale* (ALEF.) KÖRN. (No. 3291–1). 2 km E. of Sari. Awn long, empty glume glabrous and bluish-black, seed yellow.

Var. *hordeiforme* (HOST) KÖRN. (No. 3233–8). 2 km E. of Sari. Awn long,

No. 3199-1 : Isfahan - Damaneh, 45 km from Isfahan
No. 3208-5 : Suburbs of Isfahan

c. *T. polonicum* L.

As was published in 1956, a species with the name of *T. monococcum* var. *eredivianum* obtained from the collection of Dr. M. Atai, University of Tehran,

Fig. 46. *T. turgidum* var. *linnaeanum* (No. 3208-5)

a b c

Fig. 47. *T. polonicum*, new variety (No. 3232-3)

from Isfahan, revealed 2n=28, which is the chromosome number of emmer wheat

Ear: 5~7 cm long, 6~8 mm wide, lax, narrow and slender, tapering towards the apex, fragile in wedge type disarticulation.

Spikelet: 14~17 spikelets (including 3~4 abortive lower spikelets), 14~17 mm long, 3~4 mm wide, 1- or 2-grained, awns 4.5~5 cm long.

Empty glume: Glabrous, light-yellow, 14~16 mm long with 5~6 nerves and two teeth, often the secondary tooth absent.

Outer glume is slightly longer than inner glume, and is as long as empty glume. Outer glume of the first floret has many nerves and a short awn, and that of the second floret has a short tooth.

Seed: Long and narrow, red, flinty, smooth, 8 mm long, 3 mm wide, 1.0~1.2 mm thick.

In conclusion, this strain differs from other varieties of *T. polonicum* in having the following characters:

1. Semi-dwarf. 2. Hollow straw. 3. Narrow, slender, small and fragile ear. 4. Not papyraceus empty glume. 5. Small grains.

This species will be the one for which HESLOT (1959) proposed to establish a new species, *T. ispahanicum*.

III. Synthesis of amphidiploids (6x) from the hybrids, emmer wheats × *Ae. squarrosa*

Since it was made sure that *Ae. squarrosa* is one of the ancestors of common wheat, the synthesis of allohexaploid wheats from various crosses of emmer wheats with *Ae. squarrosa* has been attempted on a wide scale.

In 1950, six amphidiploids from such cross combinations were already produced (KIHARA *et al.* 1950). We used only two strains of *Ae. squarrosa typica* as male parents, while *T. dicoccoides*, *T. turgidum*, *T. durum*, *T. persicum* and *T. orientale* were used as female parents. For short they were named ABD 1, ABD 2, ABD 3, ABD 4, ABD 5, and ABD 8. Two combinations, ABD 6 and ABD 7, are missing as the F_1 hybrids did not survive until maturity (KIHARA *et al.* 1950).

As our collection of *Ae. squarrosa* was greatly enriched by this expedition we have started to synthesize more 6x wheats utilizing not only var. *typica* but also var. *meyeri* and ssp. *strangulata*

first telophase of the triploid hybrids. They were functional. In many triploid combinations, F_2 plants were obtained by selfing. For instance, the cross combinations of *T. persicum* and *Ae. squarrosa typica* gave a high percentage of pollen-fertility, and many seeds were obtained even by selfing. Also the cross combinations of *T. persicum* with *strangulata* or *meyeri* gave a high percentage of

Table 57. Pollen- and seed-fertility of 3xhybrids, emmer wheats × *Ae. squarrosa*

Stock No. (after F_2)	Cross combination (emmer wheats × *Ae. squarrosa*)			Pollen-fertility (%)	Seed-fertility (%) (highest per ear)	
					Self	Free
ABD 9	*T. dicoccoides spontaneo-nigrum*	× *strangulata*	(No. 2124)	—	7.7	—
ABD 10	〃	× *typica*	(No. 2129)	—	0.0	2.6
ABD 11	*T. persicum stramineum*	× *strangulata*	(No. 2135)	—	36.6	—
ABD 12	*T. dicoccoides spontaneo-nigrum*	× 〃	(No. 2112)	24.7	0.0	8.3
ABD 13	*T. dicoccum* (Vernal)	× 〃	(No. 2112)	48.1	2.4	8.3
—[1]	〃	× *typica*	(No. 2132)	—	3.1	2.2
ABD 14	*T. durum* (Gulab)	× *strangulata*	(No. 2118)	—	0.0	4.5
ABD 15	〃	× *typica*	(No. 2129)	—	0.0	5.1
ABD 16	*T. durum reichenbachii*	× *meyeri*	(No. 2144)	—	3.2	61.5
—[1]	〃	× *strangulata*	(No. 2111)	93.8	7.1	42.3
ABD 17	*T. persicum stramineum*	× *typica*	(No. 2107)	—	6.0	6.4
ABD 18	〃	× *strangulata*	(No. 2112)	—	16.8	21.9
ABD 19	〃	× 〃	(No. 2118)	—	7.9	12.4
ABD 20	〃	× *typica*	(No. 2129)	—	5.5	8.2
ABD 21	〃	[illegible]	(No. [illegible])	—	15.0	47.1

pollen as well as seed-fertility. The pollen-fertility was almost as high as that of normal plants (Table 57).

The fertility of the triploid hybrids varied also among the ears of an individual. It was higher in late than in early maturing ears (Table 58).

Table 58 Pollen- and seed-fertility of early and late maturing ears

Cross combination			Plant No.	Early ears		Late ears	
				pollen	seed	pollen	seed
				%	%	%	%
T. persicum var. *stramineum*	×	*Ae. squarrosa* ssp. *strangulata* (No. 2111)	26–1	42.6	41.1	75.4	47.9
			–2	—	14.5	70.6	40.0
			–3	—	21.8	77.2	29.1
			–4	—	29.1	76.1	36.1
			–5	76.5	13.1	88.2	35.1
T. persicum var. *fuliginosum*	×	〃	27–1	55.8	17.6	80.5	45.8
			–2	—	20.0	63.8	45.4
			–3	—	14.7	35.0	47.7
			–4	—	10.6	81.2	42.0

(Observed in 1957)

In Table 59, nineteen amphidiploids obtained from F_1 hybrids of Table 57 are listed. They are maintained by selfing in the experiment field of Kyoto University. Their seed-fertility in 1964 and their morphological as well as physiological characteristics are given. Fertility is nearly normal in all strains, as far as it is indicated by the highest fertility per ear. All ABD strains are breeding true in the main characters. However four strains (ABD 11, ABD 22, ABD 24 and ABD 25) derived from *T. persicum stramineum* (or *fuliginosum*) × *Ae. squarrosa strangulata* (or *meyeri*), give always rise to a number of usually not shooting dwarf offspring, whose chromosome number is normal (42).

In all wheat amphidiploids (ABD strains), the chromosome pairing is unstable. Often 2～6 univalents are found. Consequently the offspring have besides the normal euploid, hyper- and hypo-ploid numbers. This explains why the fertility of the offspring of amphidiploids varies from very low to fairly high. The euploid

59. Some characteristics of new amphidiploids derived from emmer wheats × *Ae. squarrosa*

Ear		Spikelets		Pubescence of outer glume	Plant height (cm)	Seed		Seed-fertility (%) (highest per ear)	
nsity[2]	Fragility[3]	Number per ear	Color			Hullness	Color	F_2	F_8 or F_9
.31	fragile	13.8	dark-brown	slightly pubescent	56.8	hulled	brown	59.4	85.2
.20	〃	16.8	brown	glabrous	85.3	〃	〃	87.3	80.0
.44	tough	19.1	dark-brown	〃	75.9	weakly hulled	〃	76.7	81.0
.41	fragile	19.5	〃	slightly pubescent	—	hulled	〃	36.1	94.6
.29	tough	20.3	〃	glabrous	—	〃	〃	68.4	72.1
.15	〃	16.0	〃	〃	—	〃	〃	80.0	83.5
.25	〃	10.0	〃	〃	(short)	〃	〃	4.5	—[4]
.46	〃	18.2	brown	slightly pubescent	77.2	weakly hulled	[illegible]	78.8	95.3
.93	〃	25.8	yellow	glabrous	70.0	naked	[illegible]	63.6	97.9
.24	〃	18.4	dark-brown	〃	63.8	weakly hulled	[illegible]	71.2	82.5
.43	〃	19.6	brown	〃	63.9	〃	[illegible]	70.2	72.5
.38	〃	19.6	dark-brown	〃	68.1	〃	〃	77.3	88.1
.43	〃	19.9	brown	〃	76.5	〃	〃	78.6	81.5
.53	〃	17.9	dark-brown	〃	61.8	〃	〃	79.4	78.3
.48	〃	17.6	brown	slightly pubescent	72.0	hulled	〃	69.1	83.5
.26	〃	19.3	dark-brown	glabrous	—	weakly hulled	〃	82.8	100.0
—	〃	—	〃	slightly pubescent	—	〃	〃	85.9	—

4 and 25 were obtained in 1958, and ABD 12~23 in 1959. 2) Number of spikelets/length of ear.
dge type disarticutation of ear; tough signifies that when forced, upper part of ear breaks in barrel type, and
type. 4) Lost after F_8.

field. During our collecting tour between Tehran and Karaj, we found one *Triticum-Aegilops* hybrid (probably *T. vulgare* × *Ae. triuncialis*).

The flowering time of wheat and *Aegilops* overlaps in many species. After HIRAYOSHI (1941), cultivated emmer wheats flower approximately from 7.00 to 21.00. There are two peaks, one around 9.00 and the other at 15.00. *Ae. squarrosa* has two peaks, one around 9.00 and the other at 13.00~14.00. The chance of hybridization is high, if they grow in close proximity. On the other hand, the flowers of a wild emmer (*T. dicoccoides spontaneo-nigrum*) open almost all simultaneously at 21.00 (HIRAYOSHI 1941). This indicates that hybridization between this wild emmer and *Ae. squarrosa* is almost impossible.

Once the hybrids had been produced, the amphidiploids might have arisen by the union of unreduced gametes as mentioned above. Thus we have found additional evidences that hexaploid wheats could have arisen from the hybridization between cultivated emmer wheats and *Ae. squarrosa*[1]. It is noteworthy that the triploid combinations with *T. persicum* had the highest F_1 fertility and the amphidiploids were morphologically similar to *T. vulgare* (KIHARA *et al.* 1950).

Table 60. Susceptibility of *Ae. squarrosa*, *Triticum* species and their amphidiploids to rusts (HIRATSUKA, unpub.)

Parental species or amphidiploid	Susceptibility to:		
	Yellow rust *Puccinia striiformis* (*P. glumarum*)	Brown rust *Puccinia recondita* f. sp. *tritici* 21_B	Black rust *Puccinia graminis* f. sp. *tritici* 21
Ae. squarrosa strangulata No. 2112	S	R-MR	S
〃 〃 〃 No. 2118	S	R-MR	S
〃 〃 *meyeri* No. 2114	S	R	R-MR
T. dicoccum (Vernal)	S	S	S
T. durum (Gulab)	S	S	S
T. persicum stramineum	S	S	S
ABD 13, *T. dicoccum* (Vernal) × *Ae. squarrosa strangulata* (No. 2112)	S	S	S
ABD 14, *T. durum* (Gulab) × *Ae. squarrosa strangulata* (No. 2118)	S	S	S

However, *T. persicum*, a Persian wheat, was not found anywhere in Iran (Persia). According to VAVILOV (1935) and FLAKSBERGER (1935), this species occurs in the north-eastern districts of Asia Minor and also in the Caucasus, where probably the origin of most of emmer wheats has to be sought.

From Table 60, we see that a synthesized strain, ABD 22, was resistant to brown rust; it was obtained from the cross, susceptible *persicum* var. *stramineum* ×resistant *meyeri*. However ABD 16, which possesses the same resistant *meyeri* genomes, was not resistant to brown rust. It was classified as moderately resistant to susceptible. Also in this case the emmer species was susceptible to brown rust. So it seems that the inheritance pattern is not simple.

As to the relationship to black rust, ABD 22, an amphidiploid between susceptible *persicum* var. *stramineum* and resistant *meyeri*, was susceptible. In this case the susceptible character of *persicum* is dominant (or epistatic) over the resistant character of *meyeri*. So far as our investigations are concerned, all amphidiploids derived from susceptible parents were susceptible. So it seems that resistant 6x strains can be synthesized only when the *squarrosa* parent has the resistant gene.

Summary and Conclusion

This is a general survey of species and varieties of wheat and *Aegilops* collected in Pakistan, Afghanistan and Iran by the members of the Kyoto University Scientific Expedition to the Karakoram and Hindukush in 1955.

As we laid our emphasis on the collection of *Ae. squarrosa*, we paid extreme attention to finding many varieties and forms of this species from the whole area. However wheat and other species of *Aegilops* were collected whenever possible.

According to geographical as well as ecological conditions, the whole area has been divided into nine regions: namely Quetta, Kabul, Pul-i-Khumri, Maimana, Tehran, Isfahan, Gorgan, Pahlavi and Tabriz. In the Isfahan region not a single species of *Aegilops* was found, but in all the other regions many *Triticum* and *Aegilops* species were collected.

1. *Aegilops*

route covering 320 km.

(b) *Ae. crassa* includes 4x and 6x forms. All strains from Iran and the south-eastern province of Afghanistan were 4x, while along the northern stretch of the Hindukush Range, in the Pul-i-Khumri and Maimana regions 4x and 6x were found mixed together. Accordingly, it is thought that 6x *crassa* originated in these regions from the hybridization between 4x *crassa* and *Ae. squarrosa*.

(c) *Ae. cylindrica* was found in the Tehran region, where most probably is the eastern limit of its distribution.

(d) *Ae. triuncialis* includes two subspecies, ssp. *eu-triuncialis* and ssp. *orientalis*. Ssp. *eu-triuncialis* was found in all parts of Iran, except for the coastal area of the Caspian Sea; it was also found in the Pul-i-Khumri region of Afghanistan. However, ssp. *orientalis* was found only in the Maimana region.

(e) *Ae. columnaris* was found in the Tabriz and Tehran regions. These are new findings in its discovered geographical distribution.

2) Morphological characters: Plant height, tillering habit (procumbent or erect), waxiness (waxy or non-waxy) of leaves, color of seedlings, color of ears, hairiness (pubescent or glabrous) of glumes, and awnedness of glumes, etc. were studied. Wide variations were found especially in *Ae. squarrosa* and *Ae. triuncialis*. For instance, tall plants with erect culms and large grains were found in *Ae. squarrosa* strains collected from wheat fields, while variations were slight in *Ae. cylindrica*.

Ae. crassa with awnless ear was found in the south-eastern province of Afghanistan. This will be a new variety.

3) Physiological characters: Earliness, seed-fertility, winter- or spring-habit, and resistance to rusts. Some strains of *Ae. squarrosa* collected in the south-eastern provinces of Afghanistan had spring-habit, while all other *Ae. squarrosa* strains exhibited winter-habit.

Some strains of var. *meyeri* and ssp. *strangulata* of *Ae. squarrosa* have been found to be resistant to brown and black rusts.

4) Hybrids from inter- and intra-regional cross-combinations were raised among *Ae. squarrosa* strains. The fertility of the F_1 hybrids was normal in most cases; it was low in some combinations. The sterility of the intra-species hybrids seemed to depend mainly on the genotype difference between the parents

T. vulgare, one of *T. compactum*, five of *T. durum* and one of *T. turgidum*.

With respect to four morphological characteristics (awn length, hairiness of empty glumes, glume color and seed color), *T. vulgare* strains from the Tehran, Isfahan and Kabul regions showed wide variation, while the strains from the Gorgan and Tabriz regions were less variable. Three new varieties were found in our collection.

The *vulgare* strains from the Isfahan region are characterized by inflated and awnless ears. A variety of wheat with pubescent chaff has been found there. *T. vulgare* in the Tehran and Kabul regions is also rich in variation.

T. compactum was found mainly in the mountaineous area of the Kabul region and in Ardabil in the Pahlavi region. The Afghan strains were characterized by slight square-headedness, while those from Iran were normal.

Five varieties of *T. durum* were found in the Gorgan region. *Ae. squarrosa* was found there in or along the borders of *durum* wheat fields.

T. turgidum with branched ears was found in the Isfahan region. This variety seems to have been introduced recently from U. S. S. R.

A sample obtained by the courtesy of Dr. M. Atai, University of Tehran, carrying the name *T. monococcum*, revealed to be tetraploid ($2n=28$). It could be a new variety of *T. polonicum*, from morphological and cytological observation. According to Heslot (1959) this variety is a new species, *T. ispahanicum*.

3. Artificially synthesized hexaploid wheats

Nineteen new hexaploid wheats were synthesized from hybrids between emmer wheats and *Ae. squarrosa* including var. *typica*, var. *meyeri* and ssp. *strangulata*. In general, the cross combination of *T. persicum* × *Ae. squarrosa*, ssp. *strangulata* or var. *meyeri* gave high percentage of pollen- and seed-fertility in F_1 hybrids. An amphidiploid ABD No. 22 synthesized from *T. persicum* and a brown rust resistant strain of *Ae. squarrosa* var. *meyeri* was resistant to brown rust.

4. General conclusion

Since 1949, it was our conviction that common wheat arose as a hybrid between a cultivated emmer wheat and *Ae. squarrosa* (Kihara and Lilienfeld 1949). As the result of our investigations, we could add strong evidences favoring

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Appended Table 1. List of *Triticum* collected by KUSE, 1955 (* Stock No. is based on culture numbe

Stock No.*	Species and variety		Locality or s
			Quetta region:
3001-3	*T. durum* DESF.	var. *hordeiforme* (HOST) KÖRN.	Fruit Exp. Station, Que
3002-2	*T. polonicum* L.	var. *chrysospermum* KÖRN.	〃
3003-1	*T. vulgare* VILL.	var. *barbarossa* ALEF.	〃
3004-2	*T. sphaerococcum* PERC.	var. *rubiginosum* PERC.	〃
3005-3	*T. vulgare* VILL.	var. *suberythroleucon* VAV.	〃
3007-1	〃	var. *graecum* KÖRN.	Hudda (Suburbs of Que
3010-4	〃	var. *erythroleucon-compactoides* KOB.	〃
3013-6	〃	var. *erythroleucon* KÖRN.	〃
3015-1	〃	var. 〃	〃
3017-2	〃	var. *lutinflatum* VAV.	Suburbs of Quetta,
3025-3	〃	var. *graecum* KÖRN.	Agr. Exp. Station, Quet
3026-1	〃	var. *hostianum-compactoides* GÖKG.	〃
3027-1	〃	var. *erythroleucon* KÖRN.	〃
3028-3	〃	var. *erythrospermum* KÖRN.	〃
3030-2	〃	var. *velutinum-compactoides* ZHUK.	〃
3031-1	〃	var. *lutescens-compactoides* KOB.	〃
3032-5	〃	var. 〃	〃
3034-1	〃	var. *graecum* KÖRN.	〃
3035-1	〃	var. *erythrospermum* KÖRN.	〃

Appended Table 1. (Continued)

3036–10	*T. vulgare* VILL.	var. *ferrugineum* ALEF.	Agr. Exp. Station, Quet
3037–9	〃	var. *erythroleucon-compactoides* KOB.	〃
3038–6	〃	var. *meridionale* KÖRN.	〃
3040–1	〃	var. *hostianum-compactoides* GÖKG.	〃
3044–1	〃	var. *lutescens-compactoides* KOB.	〃
3045–2	〃	var. 〃	〃
3047–1	〃	var. 〃	〃
3048–1	〃	var. *velutinum-compactoides* ZHUK.	〃
3050–3	〃	var. *meridionale* KÖRN.	〃
			Kabul region:
3052–1	〃	var. *graecum* KÖRN.	Quetta – Chaman,
3053–1	〃	var. *suberythrospermum* VAV.	〃
3056–1	〃	var. *erythrospermum* KÖRN.	〃
3058–1	〃	var. *subferrugineum* VAV.	〃
3059–1	〃	var. *subferrugineum-compactoides* GÖKG.	〃
3060–1	〃	var. *ferrugineum* ALEF.	〃
3061–6	〃	var. *suberythrospermum* VAV.	〃
3063–2	〃	var. 〃	〃
3064–2	〃	var. *subgraecum* VAV.	Suburbs of Chaman,
3065–9	〃	var. 〃	〃
3068–8	〃	var. *subferrugineum* VAV.	〃

Appended Table 1. (Continued)

3069–10	*T. vulgare* VILL.	var. *subgraecum* VAV.	Suburbs of Chaman,
3070–1	〃	var. *suberythrospermum* VAV.	〃
3072–1	〃	var. *submeridionale* VAV.	〃
3073–1	〃	var. *erythrospermum-compactoides* KOB.	〃
3074–1	〃	var. *ferrugineum* ALEF.	〃
3075–1	〃	var. *meridionale* KÖRN.	Suburbs of Kandahar,
3076–4	〃	var. *submeridionale* VAV.	〃
3078–10	〃	var. 〃	Kandahar – Jaldak,
3079–2	〃	var. *submeridionale-inflatum* PALM.	〃
3080–1	〃	var. *meridionale-compactoides* GÖKG.	〃
3081–3	〃	var. *graecum* KÖRN.	〃
3082–2	〃	var. 〃	〃
3083–1	〃	var. *erythrospermum* KÖRN.	〃
3084–10	〃	var. *submeridionale-inflatum* PALM.	〃
3085–8	〃	var. *hostianum-compactoides* GÖKG.	Jaldak,
3086–7	〃	var. *graecum-compactoides* KOB.	〃
3087–1	〃	var. *erythrospermum* KÖRN.	Jaldak – Ghazni,
3089–6	〃	var. *graecum* KÖRN.	〃
3091–1	〃	var. *submeridionale* VAV.	〃
3092–9	〃	var. *hostianum-compactoides* GÖKG.	〃
3093–1	〃	var. *graecum* KÖRN.	〃

Appended Table 1. (Continued)

3096–2	*T. vulgare* VILL.	var. *ferrugineum* ALEF.	Kabul,
3097–10	〃	var. *subturcicum* VAV.	〃
3098–9	*T. compactum* HOST	var. *erinaceum* KÖRN.	〃
3099–5	*T. vulgare* VILL.	var. *ferrugineum* ALEF.	〃
3100–13	*T. compactum* HOST	var. *erinaceum* KÖRN.	〃
3101–9	*T. vulgare* VILL.	var. *ferrugineum* ALEF.	〃
3102–4	〃	var. *trucicum-compactoides* ZHUK.	〃
3103–3	〃	var. *barbarossa-compactoides* GÖKG.	〃
3105–1	〃	var. *barbarossa* ALEF.	〃
3106–9	〃	var. *ferrugineum* ALEF.	〃
3107–1	〃	var. *erythrospermum* KÖRN	〃
3108–3	*T. compactum* HOST	var. *erinaceum* KÖRN.	〃
3109–10	*T. vulgare* VILL.	var. *ferrugineum* ALEF.	〃
3110–10	〃	var. *barbarossa-compactoides* GÖKG.	〃
3111–5	〃	var. *ferrugineum* ALEF.	〃
3112–3	〃	var. *erythrospermum-compactoides* KOB.	〃
3114–6	〃	var. *ferrugineum* ALEF.	〃
3117–1	〃	var. *meridionale* KÖRN.	Unknown,
3118–4	〃	var. *erythroleucon* KÖRN.	〃
3121–6	〃	var. *subferrugineum* VAV.	Kabul – Pul-i-Khumri,
3123–1	〃	var. *hostianum* CLEM.	〃

Appended Table 1. (Continued)

3124-1	*T. vulgare* VILL.	var. *barbarossa* ALEF.	Kabul - Pul-i-Khumri,
			Pul-i-Khumri region :
3125-2	〃	var. *erythroleucon* KÖRN.	Kabul - Pul-i-Khumri,
3126-10	〃	var. *ferrugineum* ALEF.	〃
			Maimana region :
3127-4	〃	var. *trucicum* KÖRN.	Andkui - Maimana,
3128-1	〃	var. *erythrospermum* KÖRN.	〃
3129-6	〃	var. *trucicum* KÖRN.	〃
3130-3	〃	var. *griseum* VAV.	〃
3131-4	〃	var. *ferrugineum-compactoides* KOB.	Maimana,
3132-6	〃	var. *subbarbarossa-inflatum* PALM.	〃
3133-10	〃	var. 〃	〃
3134-1	〃	var. 〃	〃
3136-9	〃	var. *trucicum* KÖRN.	Herat, Afghanistan - Ma
3137-4	〃	var. *erythroleucon* KÖRN.	〃
3138-10	〃	var. *trucicum* KÖRN.	〃
			Tehran region (I) :
3139-8	〃	var. *erythroleucon* KÖRN.	Herat, Afghanistan - Ma
3140-2	〃	var. *erythrospermum* KÖRN.	〃
3141-1	〃	var. *subferrugineum-inflatum* PALM.	〃
3143-9	〃	var. *erytherospermum* KÖRN.	〃

Appended Table 1. (Continued)

3144–5	*T. vulgare* VILL.	var. *subferrugineum-inflatum* PALM.	Herat, Afghanistan – Mas
3145–1	〃	var. 〃	Mashhad – Shahrud,
3146–1	〃	var. *erythrospermum* KÖRM.	〃
3147–7	〃	var. *subbarbarossa-inflatum* PALM. with yellow giains (*nova*)	〃
3148–10	〃	var. *ferrugineum* ALEF.	〃
3149–2	〃	var. *subferruginum-inflatum* PALM.	〃
3150–2	〃	var. *erythrospermum* KÖRN.	〃
3151–3	〃	var. *barbarossa* ALEF.	〃
3152–8	〃	var. *suberythroleucon-compactoides* GÖKG.	〃
3153–3	〃	var. *subferrugineum-compactoides* GÖKG.	〃
3154–10	〃	var. *erythroleucon* KÖRN.	〃
3155–1	〃	var. *murinum* FLAKSB.	〃
3156–4	〃	var. *ferrugineum-compactoides* KOB.	〃
3157–6	〃	var. *graecum* KÖRN.	〃
3158–2	〃	var. *hostianum* CLEM.	〃
3159–1	〃	var. *suberythroleucon-inflatum* FRENK.	〃
3160–10	〃	var. 〃	〃
3161–8	〃	var. *erythrospermum* KÖRN.	〃
3162–1	〃	var. *suberythrospermum-inflatum* PALM.	〃
3163–4	〃	var. *erythroleucon* KÖRN.	Shahrud – Semnan,
3164–1	〃	var. 〃	〃

Appended Table 1. (Continued)

			Isfahan region:
3165-3	*T. vulgare* Vill.	var. *khorossanicum* Vav.	Suburbs of Isfahan,
3166-10	〃	var. *subgraecum* Vav.	〃
3167-1	〃	var. *khorossanicum* Vav.	〃
3168-7	〃	var. *subrubromurinum* Gökg.	〃
3169-10	〃	var. *khorossanicum* Vav.	Isfahan – Saman,
3171-5	〃	var. *nigromeridionale* Gökg.	〃
3172-5	〃	var. *lutinflatum* Vav.	〃
3173-3	〃	var. *subferrugineum-compactoides* Gökg.	〃
3174-3	〃	var. 〃	〃
3175-2	〃	var. *erythrospermum-compactoides* Kob.	Suburbs of Saman,
3176-1	〃	var. *erythrospermum* Körn.	Suburbs of Shahr-Kord,
3177-6	〃	var. *subgraecum* Vav.	〃
3178-2	〃	var. *subnigroturcicum* Gökg.	〃
3179-10	〃	var. *subbarbarossa-inflatum* Palm. with yellow grains (*nova*)	Shahr-Kord – Isfahan,
3180-10	〃	var. *subrubromurinum* Gökg.	〃
3181-1	〃	var. *lutinflatum* Vav.	〃
3182-3	〃	var. *suberythrospermum* Vav.	〃
3184-1	〃	var. *lutinflatum* Vav.	〃
3185-1	〃	var. *khorossanicum* Vav.	〃
3186-1	〃	var. *subgraecum* Vav.	〃

(Continued)

are Vill.	var. *turcomanicum* Kob.	Isfahan – Damaneh,	Iran
〃	var. 〃	〃	〃
〃	var. *albinflatum* Vav.	〃	〃
〃	var. *khorossanicum* Vav.	〃	〃
〃	var. 〃	〃	〃
〃	var. *subechinodes-inflatum*	〃	〃
〃	var. *lutinflatum* Vav.	〃	〃
idum L.	var. *linnaeanum* Alef.	〃	〃
〃	var. 〃	〃	〃
are Vill.	var. *subferrugineum-inflatum* Palm.	〃	〃
〃	var. *albinflatum* Vav.	〃	〃
〃	var. *subferrugineum* Vav.	〃	〃
〃	var. *suberythrospermum-inflatum* Palm.	〃	〃
〃	var. *suberythrospermum* Vav.	〃	〃
〃	var. *hostianum* Körn.	〃	〃
〃	var. *hostianum-compactoides* Gökg.	〃	〃
〃	var. *erythrospermum* Körn.	〃	〃
idum L.	var. *linnaeanum* Alef.	Suburbs of Isfahan,	〃
are Vill.	var. *heraticum* Kob.	〃	〃
		Tehran region (II):	
〃	var. *erythroleucon* Körn.	Tehran – Ghazvin,	〃

Appended Table 1. (Continued)

3213-3	*T. vulgare* VILL.	var. *erythroleucon* KÖRN.	Tehran – Ghazvin,
3214-1	〃	var. *echinodes-inflatum* VAV. with lax ear (*nova*)	Karaj (Suburbs of Tehr
3215-1	〃	var. *subbarbarossa-inflatum* PALM.	〃
3217-10	〃	var. 〃	〃
3219-1	〃	var. *erythroleucon-compactoides* KOB.	〃
3220-7	〃	var. *subbarbarossa-inflatum* PALM.	〃
3221-6	〃	var. *hostianum* KÖRN.	〃
3223-1	〃	var. *trucicum* KÖRN.	〃
3225-5	〃	var. *barbarossa* ALEF.	〃
3226-1	〃	var. *suberythroleucon-compactoides* GÖKG.	〃
3226-10	〃	var. 〃	〃
3227-2	*T. spelta* L.	var. *vulpinum* ALEF.	Agr. Exp. Sta., Tehran,
3228-8	*T. orientale* PERC.	var. *insigne* PERC.	〃
3229-5	*T. spelta* L.	var. *arduini* KÖRN.	〃 (Isfahan
3230-3	*T. vulgare* VILL.	var. *subferrugineum* VAV.	〃
3231-10	〃	var. *subbarbarossa-inflatum* PALM.	〃
3232-3	*T. polonicum* L.	new variety (*nova*)	〃 (Near Isfa
			Gorgan region (I):
3233-8	*T. durum* DESF.	var. *hordeiforme* (HOST) KÖRN.	Sari – Behshahr,
3234-7	*T. vulgare* VILL.	var. *ferrugineum* ALEF.	〃
3235-8	〃	var. *erythrospermum* KÖRN.	〃

Appended Table 1. (Continued)

3236-2	*T. vulgare* VILL.	var. *ferrugineum* ALEF.	Sari – Behshahr,
3236-7	〃	var. 〃	〃
3237-3	〃	var. *erythrospermum* KÖRN.	〃
3238-2	〃	var. *erythrospermum-compactoides* KOB.	〃
3241-1	〃	var. *erythrospermum* KÖRN.	〃
3242-4	〃	var. 〃	〃
3243-8	〃	var. 〃	〃
3244-1	〃	var. 〃	〃
3245-4	〃	var. *erythrospermum-compactoides* KOB.	Suburbs of Gorgan,
3246-3	〃	var. 〃	Gorgan – Khoshyailagh,
3248-2	〃	var. 〃	〃
3249-3	*T. durum* DESF.	var. *obscurum* KÖRN.	〃
3253-4	*T. vulgare* VILL.	var. *erythrospermum* KÖRN.	〃
3254-1	〃	var. 〃	〃
3255-6	*T. durum* DESF.	var. *murciense* KÖRN.	〃
3256-1	〃	var. 〃	〃
			Tehran region (III):
3257-1	*T. vulgare* VILL.	var. *barbarossa* ALEF.	Khoshyailagh,
3258-6	〃	var. *erythrospermum* KÖRN.	〃
3259-1	〃	var. *subbarbarossa-inflatum* PALM. with yellow grains (*nova*)	Khoshyailagh – Shahrud,
3260-8	〃	var. *suberythroleucon-inflatum* FRENK.	〃

Appended Table 1. (Continued)

3261–1	*T. vulgare* VILL.	var. *trucicum* KÖRN.	Suburbs of Tehran,
3262–10	〃	var. *ferrugineum* ALEF.	〃
3263–2	〃	var. *erythrospermum* KÖRN.	〃
3264–8	〃	var. *ferrugineum* ALEF.	〃
3265–1	〃	var. *meridionale* KÖRN.	〃
3267–1	〃	var. *erythroleucon* KÖRN.	Tehran – Firuzkuh,
3269–6	〃	var. *ferrugineum* ALEF.	〃
3270–2	*T. durum* DESF.	var. *valenciae* KÖRN.	〃
3271–8	〃	var. 〃	〃
3272–9	*T. vulgare* VILL.	var. *graecum-compactoides* KOB.	〃
3273–2	〃	var. 〃	〃
3274–5	〃	var. 〃	〃
3276–10	〃	var. *subbarbarossa-inflatum* PALM. with yellow grains (*nova*)	Suburbs of Firuzkuh,
3277–6	〃	var. *subferrugineum* VAV.	〃
3278–1	〃	var. *suberythrospermum-inflatum* PALM.	〃
3279–2	〃	var. *graecum* KÖRN.	〃
3280–3	〃	var. *erythroleucon* KÖRN.	〃
3281–10	〃	var. *subbarbarossa-inflatum* PALM. with yellow grains (*nova*)	〃
3282–2	〃	var. 〃	〃
3283–1	〃	var. 〃	〃
3284–1	〃	var. *transcaspicum* VAV.	〃

Appended Table 1. (Continued)

3285-8	*T. vulgare* VILL.	var. *suberythrospermum* VAV.	Suburbs of Firuzkuh,
3286-1	〃	var. *alborubrum-inflatum* VAV.	〃
3287-3	〃	var. *subbarbarossa-inflatum* PALM. with yellow grains (*nova*)	〃
3288-8	〃	var. *erythrospermum* KÖRN.	〃
3289-9	〃	var. *ferrugineum* ALEF.	Firuzkuh – Sari,
3290-9	〃	var. 〃	〃
			Gorgan region (II):
3291-1	*T. durum* DESF.	var. *provinciale* (ALEF.) KÖRN.	Suburbs of Sari,
3292-2	*T. vulgare* VILL.	var. *erythrospermum* KÖRN.	Sari – Behshahr,
3294-1	〃	var. *ferrugineum* ALEF.	〃
3295-6	〃	var. *erythrospermum-compactoides* KOB.	Suburbs of Behshahr,
			Pahlavi region:
3296-7	〃	var. *erythrospermum* KÖRN.	Suburbs of Chalus,
3296-12	〃	var. 〃	〃
3297-9	〃	var. *erythrospermum-compactoides* KOB.	〃
3299-1	〃	var. *erythrospermum* KÖRN.	Suburbs of Pahlavi,
3302-3	〃	var. *erythrospermum-compactoides* KOB.	Astara – Ardabil,
3303-4	〃	var. *ferrugineum-compactoides* KOB.	〃
3304-3	*T. compactum* HOST	var. *erinaceum* KÖRN.	〃
3305-1	*T. vulgare* VILL.	var. *barbarossa* ALEF.	〃
3306-2	*T. compactum* HOST	var. *erinaceum* KÖRN.	〃

Appended Table 1. (Continued)

3307–9	*T. vulgare* VILL.	var. *ferrugineum-compactoides* KOB.	Suburbs of Ardabil
3308–4	*T. compactum* HOST	var. *erinaceum* KÖRN.	〃
3309–6	*T. vulgare* VILL.	var. *ferrugineum-compactoides* KOB.	〃
3310–4	〃	var. *ferrugineum* ALEF.	〃
3311–1	〃	var. *ferrugineum-compactoides* KOB.	〃
3312–6	〃	var. *erythrospermum-compactoides* KOB.	〃
3313–7	〃	var. *meridionale* KÖRN.	Ardabil – Sarab,
3314–2	〃	var. *erythroleucon* KÖRN.	〃
3315–1	〃	var. 〃	〃
3316–2	〃	var. *meridionale* KÖRN.	〃
3316–9	〃	var. 〃	〃
3317–5	〃	var. *ferrugineum* ALEF.	〃
3318–1	〃	var. *erythroleucon* KÖRN.	〃
3319–10	〃	var. *ferrugineum* ALEF.	〃
3320–8	〃	var. 〃	〃
3321–7	〃	var. *erythrospermum* KÖRN.	〃
3322–1	〃	var. *ferrugineum* ALEF.	〃
3323–4	〃	var. *meridionale* KÖRN.	〃
3324–3	〃	var. *ferrugineum* ALEF.	〃
3325–5	〃	var. *erythrospermum* KÖRN.	〃
3326–1	〃	var. *merdidionale-compactoides* GÖKG.	〃

Appended Table 1. (Continued)

3327–1	*T. vulgare* VILL.	var. *fulvocinereum* FLAKSB.	Ardabil – Sarab,
3328–2	〃	var. *ferrugineum* ALEF.	〃
3329–1	〃	var. *barbarossa* ALEF.	Suburbs of Sarab,
3331–8	〃	var. *meridionale* KÖRN.	〃
3332–1	〃	var. *nigromeridionale* GÖKG. with brown grains (*nova*)	〃
3333–4	〃	var. *meridionale* KÖRN.	Sarab – Tabriz,
3335–3	〃	var. *ferrugineum* ALEF.	〃
3337–7	〃	var. *fulvocinereum* FLAKSB.	〃
3338–6	〃	var. *erythrospermum* KÖRN.	〃
3339–2	〃	var. *hostianum* KÖRN.	〃
			Tabriz region:
3341–1	〃	var. 〃	Sarab – Tabriz,
3342–2	〃	var. *erythrospermum* KÖRN.	〃
3343–10	〃	var. *meridionale* KÖRN.	Suburbs of Tabriz,
3344–7	〃	var. *erythrospermum-compactoides* KOB.	〃
3345–5	〃	var. *hostianum* KÖRN.	〃
3346–8	〃	var. *meridionale* KÖRN.	〃
3347–2	〃	var. 〃	〃
3348–5	〃	var. *erythrospermum* KÖRN.	〃
3349–1	〃	var. *meridionale* KÖRN.	〃
3350–3	〃	var. *hostianum* KÖRN.	Tabriz – Mahabad,

Appended Table 1. (Continued)

3351–1	*T. vulgare* VILL.	var. 〃	Tabriz – Mahabad,
3352–3	〃	var. *ferrugineum* ALEF.	〃
3353–2	〃	var. 〃	〃
3354–2	〃	var. *erythrospermum* KÖRN.	〃
3355–3	〃	var. *nigrocyanorubrum* GÖKG.	Suburbs of Mahabad,
3356–1	〃	var. *ferrugineum* ALEF.	〃
3360–2	〃	var. 〃	〃
3361–2	〃	var. *meridionale* KÖRN.	Suburbs of Rezaiyeh,
3362–10	〃	var. *velutinum* KÖRN.	Rezaiyeh – Khoy,
3363–2	〃	var. *barbarossa* ALEF.	Khoy – Tabriz,
3364–2	〃	var. *erythrospermum-compactoides* KOB.	〃
3365–1	〃	var. *meridionale* KÖRN.	〃
3367–7	〃	var. 〃	〃
3369–4	〃	var. *nigromeridionale* GÖKG. with brown grains (*nova*)	〃
3370–9	〃	var. *meridionale* KÖRN.	〃
3371–2	〃	var. *ferrugineum* ALEF.	〃
			Tehran region (IV):
3374–1	〃	var. *subbarbarossa-inflatum* PALM.	Karaj (Suburbs of Teh
3438–1	*T. aegilopoides* BAL.	var. *boeoticum* PERC.	Agr. Exp. Sta., Tehran,
3439–1	〃	var. *thaoudar* PERC.	〃

Morphological and cytological studies on various species of Gramineae collected in Pakistan, Afghanistan, and Iran[1]

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During the Kyoto University Scientific Expedition to the Karakoram and Hindukush in 1955, a considerable number of wild and cultivated species of Gramineae was collected in the form of herbarium specimens or panicles. The seeds collected have been planted and maintained since 1956 in the experiment fields at the Laboratory of Genetics, Faculty of Agriculture, Kyoto University, and the National Institute of Genetics, respectively. The distribution and chromosome number of those species of Gramineae other than ***Aegilops***, ***Echinochloa***, ***Hordeum***, ***Lolium***, ***Secale***, and ***Triticum*** are reported in the present paper.

Identification of species was made by Dr. Jisaburo OHWI, National Science Museum, Tokyo, except the species belonging to the genus ***Eremopyrum***, which were identified by Dr. N. L. BOR, Royal Botanic Gardens, Kew, and Dr. A. MELDERIS, British Museum (Natural History), London.

Chromosome number was determined at the mitotic metaphase of root-tip cells using a Feulgen aceto-carmine squash method.

Species, collection number, source, and chromosome number of the strains examined are listed in Appended Table 1.

Agropyron: Three species were recognized in the present collection, ***A. intermedium*** (HOST) P. BEAUV. (?), ***A. trichophorum*** (LINK) RICHT. and ***A.*** sp., probably ***A. repens*** (LINN.) P. BEAUV. or ***A. intermedium***.

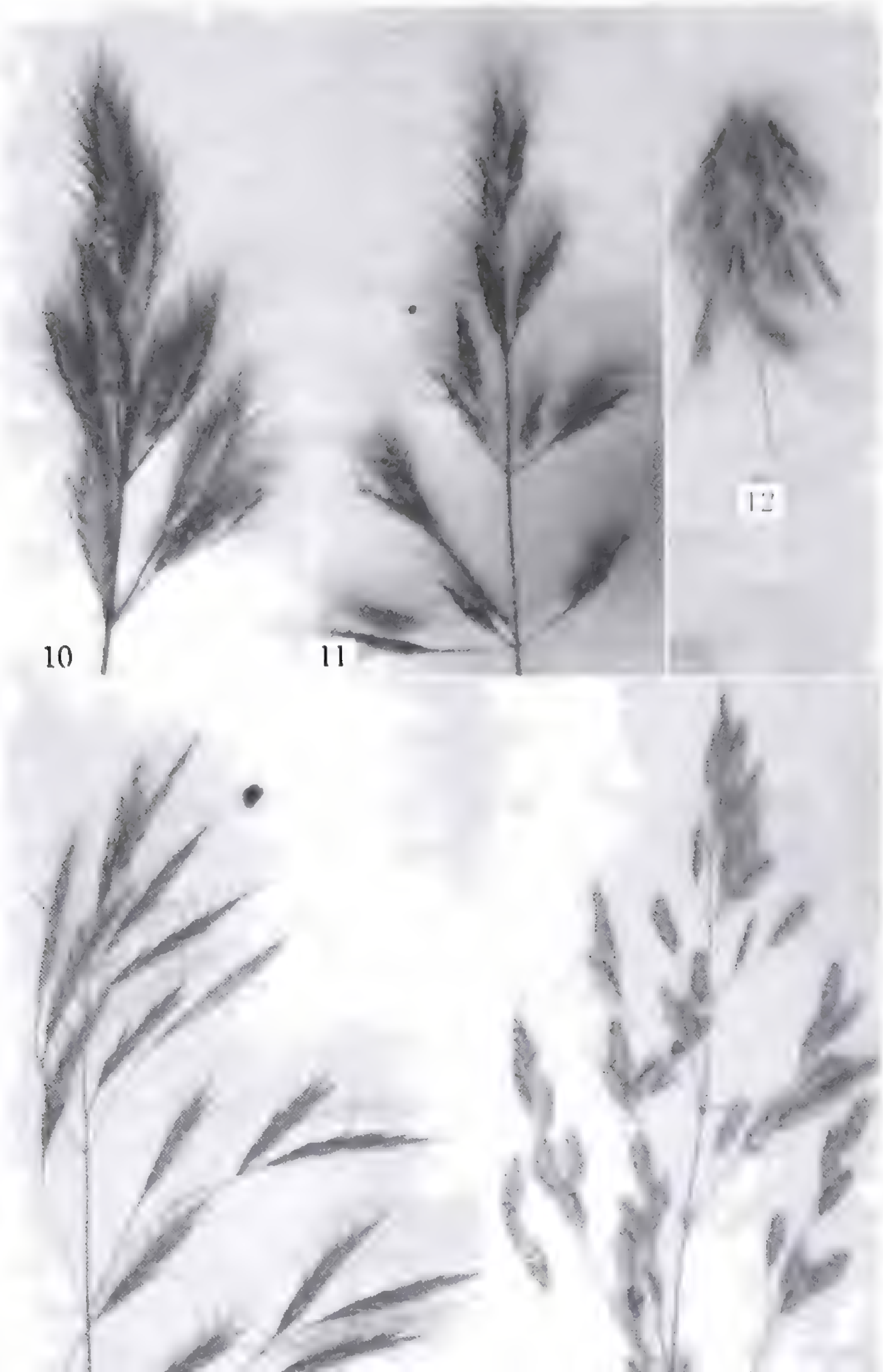
A. intermedium (?) was collected near Tehran and Tabriz, Iran. Of four strains collected, one (No. 7014) was octoploid (2n=56), whereas only the hexaploid number has previously been reported for ***A. intermedium*** (2n=42; PETO

Figs. 1～9. Spikes of *Agropyron*, *Elymus*, *Festuca* and *Henrardia* ×0.38

1～3. *Agropyron trichophorum* (Nos. 7023, 7023 and 7024)
4. *A.* sp., probably *A. repens* or *A. intermedium* (No. 7003)
5. *Elymus dahuricus* (No. 7066)
6. *Festuca elatior* (No. 7182)
7. *F. Myuros* (No. 7183)
8. *Henrardia persica* var. *persica* (No. 7333)
9. *H. persica* var. *glaberrima* (No. 7334)

waxy and pubescent, and one was non-waxy and non-pubescent. This indicates genetic heterogeneity of the orignal clone of this strain. The two strains were examined cytologically, and both were hexaploid ($2n=42$; Fig. 68), in conformance

Iran (Fig. 18). It seemed to be a cross-pollinated species, for it is protogynous and has large anthers. Flowering progressed from top to bottom of a spike. One of the seven pairs of chromosomes had a satellite, while the rest has median or submedian centromeres (Fig. 69). The chromosome number, $2n=14$, was also reported by CHURCH (1929*) and KATTERMANN (1930*).



Brachypodium sylvaticum (HUDS.) P. BEAUV.: Three strains were collected in Iran (Figs. 19 and 20). Plants were non-waxy and glabrous except for the nodes of the stem. The somatic chromosome number was 18 (Fig. 70). The same chromosome number was observed by AVDULOV (1931) and others. The chromosomes were very small compared with other groups of Gramineae.

Bromus: Seven species of this genus, *B. brizaeformis* FISCH. *et* MEYER, *B. Commutatus* SCHRADER, *B. Danthoniae* (DESF.) TRIN., *B. macrostachys* DESF., *B. madritensis* LINN., *B. racemosus* HUDS. and *B. secalinus* LINN., were identified. Fig. 85 shows the collection localities of the 21 strains of this genus that were examined. Spikelet characteristics of seven species are shown in Figs. 23~31.

B. brizaeformis was collected only in Astara, Iran (Fig. 15). It was found to be a diploid species (2n=14), as observed also by AVDULOV (1931). All chromosomes had median or submedian centromeres (Fig. 71). *B. Commutatus* was collected in Gorgan and Tabriz, Iran (Fig. 16). Spikelets of this species were awned, and the awns curved when spikes were ripe. Nodes were slightly pubescent. Purple color developed in the stem at maturity. It was a diploid species (2n=14). This species was also collected in Nuristan by KITAMURA (1960). Diploid (FELFÖLDY 1947**), tetraploid (KNOWLES 1944*) and octoploid (NIELSEN 1939*) of this species have been reported. *B. Danthoniae* (Figs. 10 and 11) was obtained in various places along the expedition route. Awns of this species curved, and mature stems were purple. The seven strains examined were all diploid (2n=14), as also reported by SCHULZ-SCHAEFFER and MARKARIAN (1957**). *B. macrostachys* was found in Pul-i-Khumri, Afghanistan. Spikelets of this species were larger than those of other species, and awns of outer glumes curved sharply when spikes ripe (Figs. 13 and 29). It was a tetraploid species (2n=28). Diploid (STÄHLIN 1929*) and tetraploid (AVDULOV 1931, CUGNAC and SIMONET 1941*) of this species have been reported previously. *B. madritensis* was collected in Isfahan, Iran. Morphology of the spike and spikelet of this species were decidedly different from the other *Bromus* species (Figs. 12 and 27). The present material was a diploid (2n=14). However, tetraploid (AVDULOV 1931 and others) and hexaploid (STÄHLIN 1929*) have been reported. *B. racemosus* (Fig. 14) was collected in Pahlavi-Sari, Iran. Morphologically this species was very similar to *B. Commutatus*. It was a diploid (2n=14, Fig. 72), whose chromosomes had median or submedian centromeres. MAUDE (1940*)

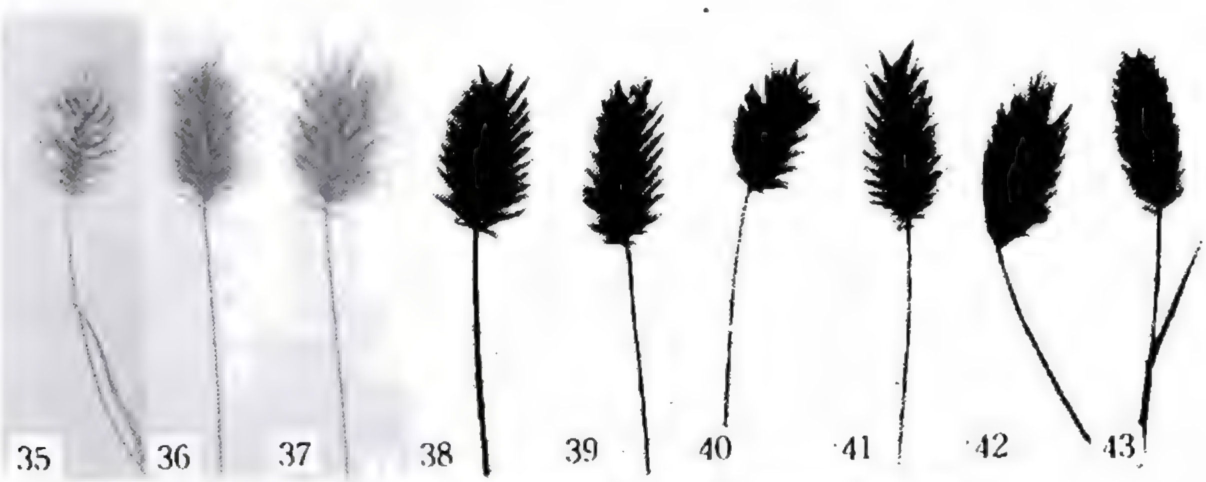
Figs. 15~22. Spikes of *Bromus*, *Alopecurus*, *Brachypodium* and *Taeniatherum* ×0.38

15. *Bromus brizaeformis* (No. 7121)

Figs. 23~34. Spikelets of *Bromus*, *Heteranthelium* and *Taeniatherum* ×0.83

two species of *Cynosurus* that have been studied cytologically, *C. balansae* Coss. *et* DUR. (AVDULOV 1931) and *C. cristatus* LINN. (STÄHLIN 1929*, ADVULOV 1931), also are 2n=14. Therefore, the basic number of this genus is seven (DARLINGTON and WYLIE 1955). Two possibilities for explaining the chromosome constitution of the present material may be advanced: (1) that one pair (the smaller pair with median centromere) is supernumerary, or (2) that there is a second basic number in this genus, x=8. It is desirable to collect other strains of this species for cytological comparison with the present material.

Dactylis glomerata LINN.: This species (Fig. 55) was collected from three different localities in Iran. It was a tetraploid (2n=28), as previously found by CHURCH (1929*) and others.



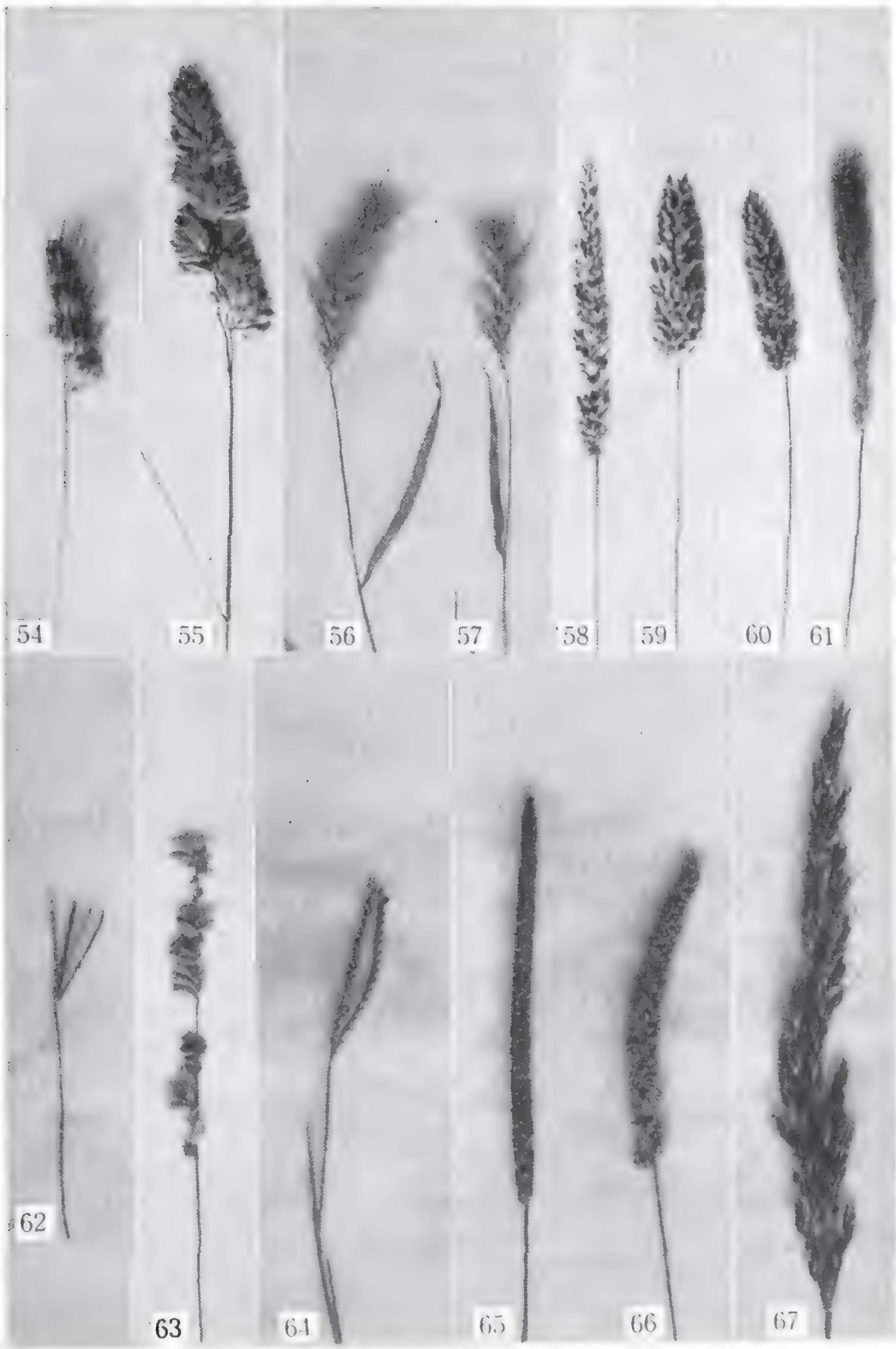
Figs. 35~43. Spikes of *Eremopyrum* ×0.38

35~39. *Eremopyrum buonapartis* var. *buonapartis* (Nos. 7035, 7036, 7038, 7042 and 7043)

40 and 41. *E. buonapartis* var. *sublanuginosum* (Nos. 7032 and 7034)

42. *E. distans* (No. 7041)

43. *E. orientale* (No. 7037)



Figs. 54~67. Spikes of twelve species of Gramineae ×0.38

54. *Cynosurus echinatus* (No. 7221)

55. *Dactylis glomerata* (No. 7212)

Elymus dahuricus TURCZ.: One strain (Fig. 5) collected at Hopar, Afghanistan was hexaploid (2n=42, Fig. 74). Tetraploid (BROWN 1948**) and hexaploid (AVDULOV 1931, MATSUMURA *et al.* 1956) have been found.

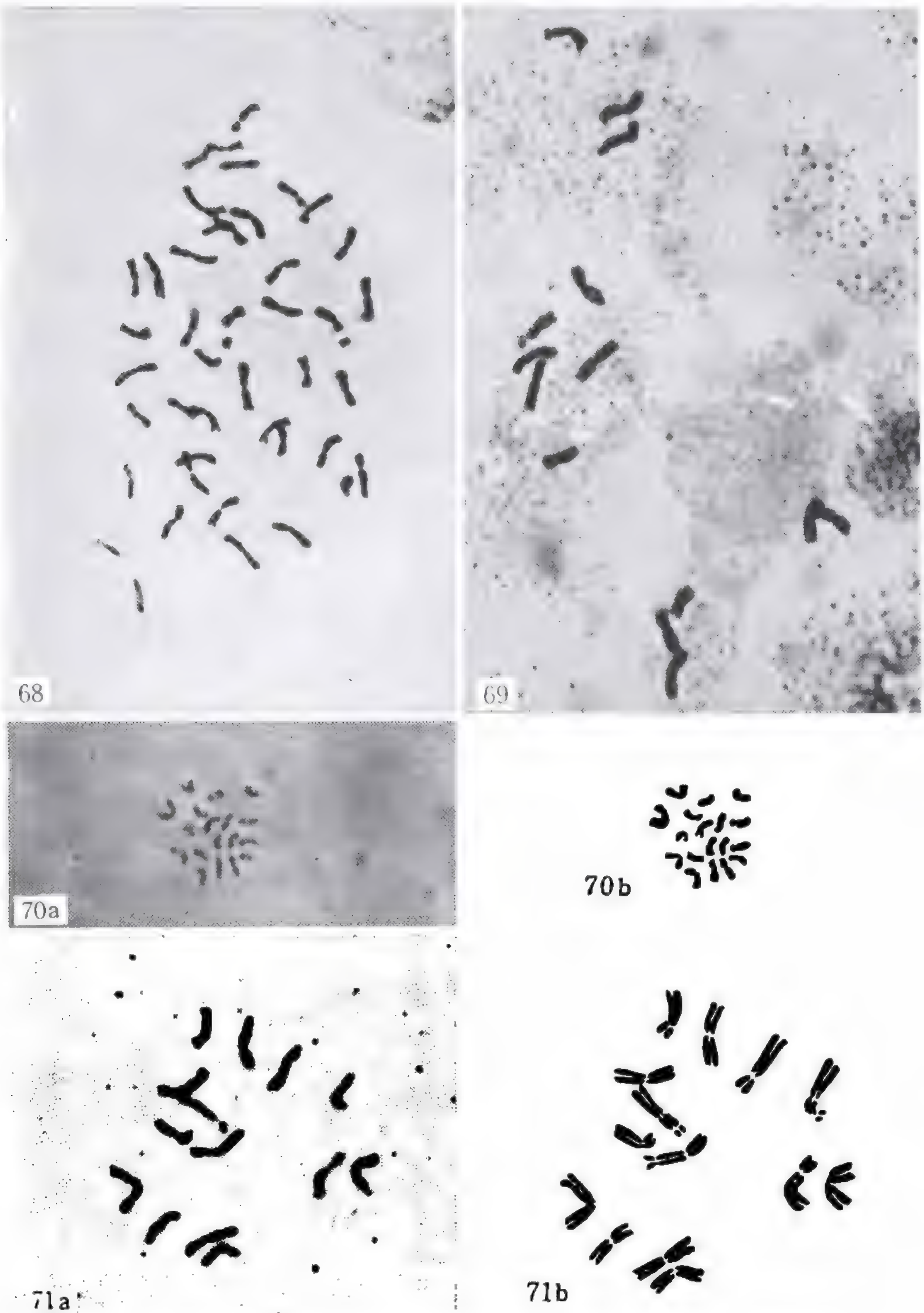
Eremopyrum: Two varieties of *E. buonapartis* (SPRENG.) NEVSKI, var. *buonapartis* and var. *sublanuginosum* (DROB.) MELDERIS (=*E. hirsutum* NEVSKI), *E. distans* (C. KOCH) NEVSKI, and *E. orientale* (LINN.) JAUB. *et* SPACH. were collected along the expedition route (Fig. 85). Size and shape of these species are very similar (Figs. 35~43), but the spikelets (Figs. 44~53) distinguish them.

Seven of the 12 strains of *Eremopyrum* examined were found to be *E. buonapartis* var. *buonapartis*. It was distributed widely in the area. Of the seven strains of var. *buonapartis*, one (No. 7035, Figs. 35 and 44), with short-awned and non-pubescent spikelets, cellected in Isfahan, Iran, was diploid (2n=14, Fig. 77). The rest, all strains of var. *buonapartis* with awnless and non-pubescent spikelets, were tetraploid (2n=28, Fig. 80). Two strains of var. *sublanuginosum* (Nos. 7032 and 7034, Figs. 40, 49 and 41, 50 respectively) with awnless and pubescent spikelets were tetraploid. *E. distans* (No. 7041, Figs. 42 and 51), a diploid with awned and hairy spikelets, was collected in Pul-i-Khumri, Afghanistan. Two strains of *E. orientale* (Nos. 7031 and 7037, Figs. 43, 52 and 53 respectively) with short-awned and pubescent spikelets found in Quetta-Chaman, Pakistan and in Ardabil-Tabriz, Iran, were tetraploid (Figs. 78 and 79). This species was collected together with *E. buonapartis* var. *sublanuginosum* in Quetta-Chaman, Pakistan.

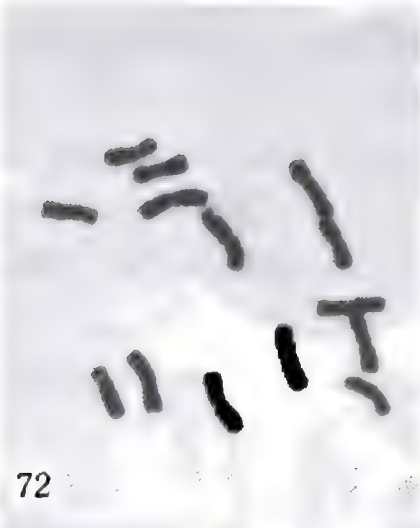
The somatic chromosome numbers of five *Eremopyrum* species were determined by SARKAR (1958). The present results differed in several points from his report, as shown in the following table (Table 1):

Table 1. Somatic chromosome numbers of four *Eremopyrum* species

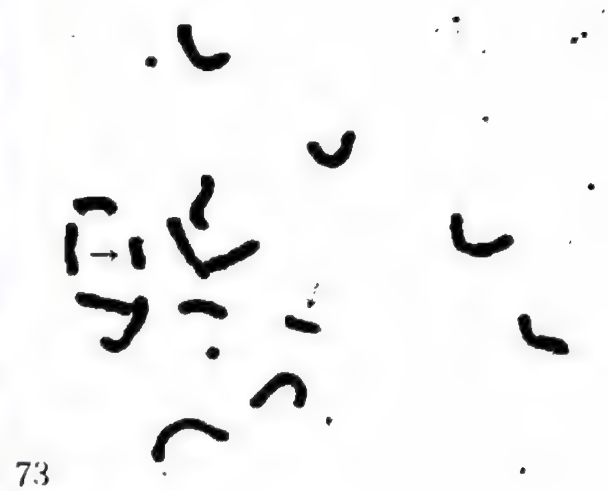
Species	SARKAR (1958)	Present results
E. buonapartis var. *buonapartis*	28	14 and 28
〃 var. *sublanuginosum* (=*E. hirsutum*)	14	28
E. distans	28	14
E. orientale	28	28



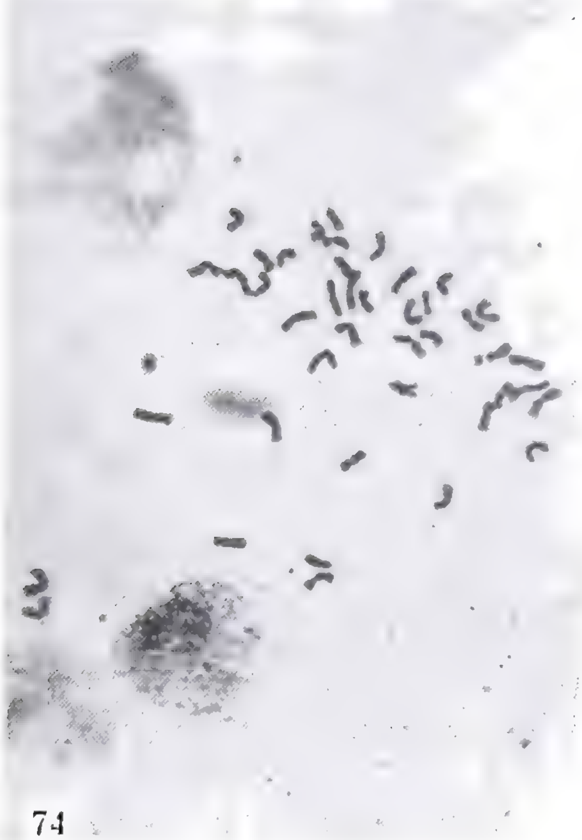
Figs. 68~71. Somatic chromosomes of *Agropyron*, *Alopecurus*,



72



73



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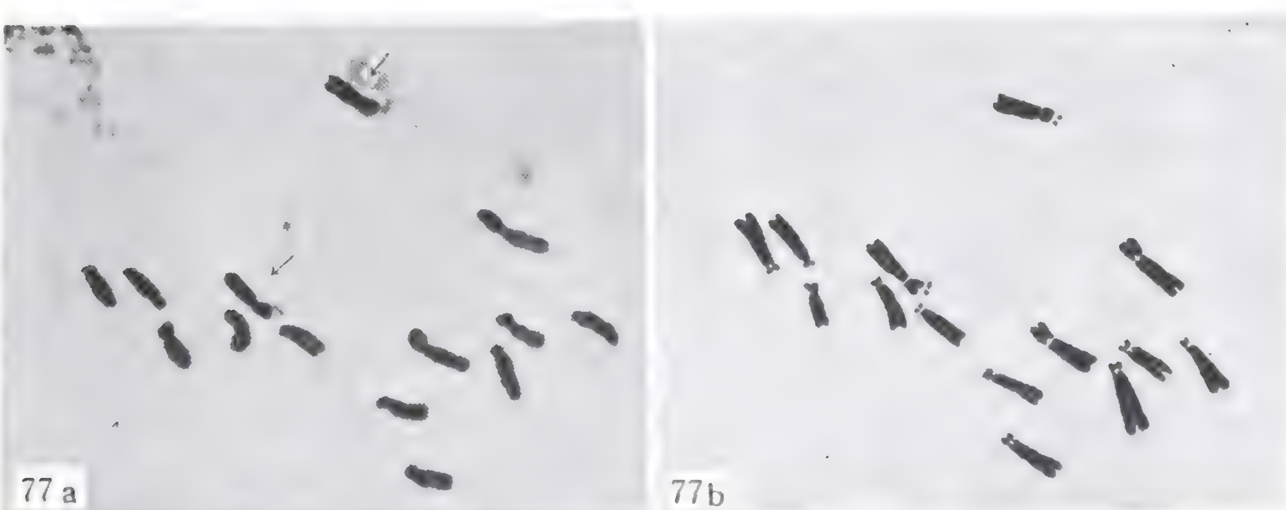
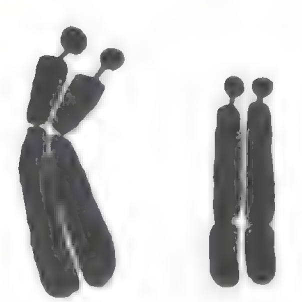
The karyotypes of two diploid species of *Eremopyrum* have been studied. In *E. triticeum*, all the chromosomes have terminal or subterminal centromeres (SARKAR 1955 and 1958, MATSUMURA and SAKAMOTO 1955). The karyotype of the other species, *E. hirsutum*, resembles that of *E. triticeum* but has one pair of chromosomes with a submedian centromere (SARKAR 1955 and 1958). Thus, the karyotypes of these two diploid species are rather similar to that of the diploid *E. buonapartis* var. *buonapartis*, except that the latter has two pairs of submedian chromosomes, including one pair with a trabant attached to the short arm (shown by arrows in Fig. 77a).

E. distans, which is fairly easily distinguished morphologically from the others (Figs. 42 and 51) has one additional submedian chromosome. It has three pairs with submedian centromeres plus four pairs with terminal or subterminal centromeres (Fig. 81). One of the chromosomes with subterminal centromere has a very small characteristic trabant quite similar to that of *E. buonapartis* var. *buonapartis* but attached to the long arm (shown by arrows in Fig. 81).





The karyotypes of two tetraploid strains, one of *E. orientale* (No. 7031) and one of *E. buonapartis* var. *buonapartis* (No. 7038), are shown in Figs. 78 and 80, respectively.

At least nine pairs of chromosomes with terminal or subterminal centromere were observed in the present study. Five pairs, including one fairly large pair and two pairs with very small trabants, could be classified as median or submedian. The trabant is very similar to those found in diploid species and is so small that sometimes it escaped from observation. In *E. orientale*, one pair of trabant chromosome resembles that of the diploid *E. buonapartis* var. *buonapartis* in having the trabant on the short arm (a in Fig. 79), and the other pair is very much like that of *E. distans* in having it on the long arm (b in Fig. 79). In Fig. 80 of tetraploid *E. buonapartis* var. *buonapartis* only one of each of these two kinds of trabant chromosomes can be seen, as indicated by the arrows in the figure. Similar figures were observed in *E. orientale* (Fig. 78).

SARKAR (1958) assumed that the tetraploid *Eremopyrum* originated as an amphidiploid between a diploid species of *Eremopyrum* and a diploid crested

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Agropyron. From the present study, however, it is more reasonable to assume that the tetraploid species are derivatives from amphidiploids between diploid species of this genus such as the diploid *E. buonapartis* var. *buonapartis* and *E. distans*. In particular, this idea receives support from the presence of the characteristic trabant-chromosomes in the tetraploid species.

Festuca: Two species, *F. elatior* LINN. and *F. Myuros* LINN., were collected in Iran (Figs. 6 and 7). Cytological examination of two strains of *F. elatior* showed that one strain (No. 7182) was diploid (2n=14) and another strain (No. 7181) was hexaploid (2n=42) in spite of the morphological similarity between the two strains. Diploid and hexaploid of this species were observed by STÄHLIN (1929*) and others. *F. Myuros* could not be examined cytologically.

Henrardia persica (BOISS.) C. E. HUBBARD: This species was collected in Iran. Also, seeds of three strains (Nos. 7339–7341) were given by the Department of Agriculture of Iran, Tehran, to the members of the expedition. All strains were classified into two varieties, var. *persica* with dense hairs on the spikes (Fig. 8)

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and var. ***glaberrima*** (HAUSSKN.) C. E. HUBBARD with glabrous spikes (Fig. 9). Both varieties were found sympatrically in a place between Ardabil and Tabriz, Iran. Cytological obsevations of both varieties showed 2n=14, with the centromeres characteristically terminal and one pair has a secondary constriction almost at the end of the long arm (Fig. 82). The basic chromosome number of this genus is x=7.

Heteranthelium piliferum (BANKS *et* SOLAND.) HOCHST.: This species was found in Tehran and Mahabad, Iran, and in Pul-i-Khumri, Afghanistan (Figs. 56 and 57). The chromosome number was 2n=14, consisting of one pair with a clear satellite and six pairs with median or submedian centromeres (Fig. 75). A very similar karyotype was observed by CHENNAVEERAIAH and SARKAR (1959).

Koeleria phleoides (VILL.) PERS.: This species was collected in Pul-i-Khumri, Afghanistan (Fig. 58). The somatic chromosome number was 26, with all chromosomes having median or submedian centromeres (Fig. 76). AVDULOV (1931) observed the same chromosome number in this species.

Phalaris minor RETZ.: Three strains were collected in Afghanistan (Figs. 59 and 60). Actively growing root-tips of this species contained an unknown brownish red pigment. Chromosome number found in the root-tips was 28, as also reported by AVDULOV (1931) and others.

Polypogon monospeliensis DESF.: This species was collected in Kandahar, Afghanistan (Fig. 61). The chromosome number of this species was 2n=28, as found by AVDULOV (1931).

Taeniatherum: Two species, ***T. asperum*** (SIMONK.) NEVSKI and ***T. crinitum*** (SCHREB.) NEVSKI, were collected, the former in Pakistan and Afghanistan, and the latter in Iran (Figs. 21 and 22). Both species had 2n=14 in root-tips (Figs. 83 and 84). The same chromosome number of ***T. asperum***, described as ***Elymus asper*** (SIMONK.) HAND.-MAZ., was found in Argentina by HUNZIKER (1954).

Others: ***Cynodon dactylon*** (LINN.) PERS. (Fig. 62), ***Eragrostis*** sp. (Fig. 63), ***Paspalum distichum*** LINN. (Fig. 64), ***Phleum paniculatum*** HUDS. (Fig. 65), ***Setaria verticillata*** (LINN.) P. BEAUV. (Fig. 66) and ***Sorghum halepense*** (LINN.) PERS. (Fig. 67) were collected during the expedition, but no cytological study of these species was made because of the lack of germinable seeds from the original materials.

Acknowledgement:

Fig. 85. Locality map of the species of *Bromus*

● *E. buonapartis* var. *buonapartis* ▲ *B. Danthoniae*

○ *E. buonapartis* var. *sublanuginosum* △ *B. racemosus*

◐ *E. orientale* △ *B. Commutatus*

⊕ *E. distans* ▲ *B. macrostachys*

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AVDULOV, N. P. 1931. Karyo-systematische Untersuchung der Familie Gramineen. Bull. Appl.

and *Eremopyrum* collected in Pakistan, Afghanistan and Iran

▲ *B. madritensis*

▲ *B. brizaeformis*

▲ *B. secalinus*

99–104.

KITAMURA, S. 1960. Flora of Afghanistan. Results of the Kyoto University Scientific Expedition to the Karakoram and Hindukush, 1955, Vol. III. pp. 486.

MATSUMURA, S. and S. SAKAMOTO 1955. Karyotypes of diploid *Agropyron* species. W. I. S. 2:

Appended Table 1. Species, collection No., source and chromosome number of Gramineae collected in Pakistan, Afghanistan and Iran

Species	Collection No.	Source		Chromosome number (2n)	Spike
Agropyron intermedium (Host) P. Beauv. (?)	7011	Tehran – Kraj,	Iran	—	
〃	7012	Tehran – Sari,	〃	—	
〃	7013	〃	〃	—	
〃	7014	Tabriz – Ardabil,	〃	56	
A. trichophorum (Link) Richt.	7021	Tehran – Sari,	〃	—	
〃	7022	〃	〃	—	
〃	7023	〃	〃	42	1, 2
〃	7024	Laman – Herat,	Afghanistan	42	3
A. sp. probably *A. repens* (Linn.) P. Beauv. or *A. intermedium*	7001	Kandahar – Ghazni,	〃	—	
〃	7002	〃	〃	—	
〃	7003	〃	〃	—	4
〃	7004	〃	〃	—	
〃	7005	〃	〃	—	
〃	7007	〃	〃	56	
〃	7008	Tehran – Sari,	Iran	—	
Alopecurus mysuroides Huds.	7006	Isfahan – Damaneh,	〃	14	18
〃	7261	〃	〃	—	
Brachypodium sylvaticum (Huds.) P. Beauv.	7111	Sari – Gorgan,	〃	18	19

Appended Table 1. (continued)

〃	7112	Pahlavi – Ardabil,	〃	—	20
〃	7113	〃	〃	—	
Bromus brizaeformis FISCH. *et* MEYER	7121	Astara,	〃	14	15
B. Commutatus SCHRADER	7133	Sari,	〃	14	
〃	7134	Sari – Gorgan,	〃	14	16
〃	7141	Mahabad – Khoy,	〃	14	
B. Danthoniae (DESF.) TRIN.	7161	Chaman,	Pakistan	14	10
〃	7163	Isfahan,	Iran	14	
〃	7165	Tehran,	〃	14	11
〃	7166	Tabriz,	〃	14	
〃	7167	Mahabad – Rezaiyeh,	〃	14	
〃	7170	Pul-i-Khumri,	Afghanistan	14	
〃	7171	Tashkurghan – Aq Chah,	〃	14	
B. macrostachys DESF.	7144	Pul-i-Khumri,	〃	28	13
〃	7145	〃	〃	28	
B. madritensis LINN.	7151	Isfahan,	Iran	—	
〃	7152	〃	〃	14	12
B. racemosus HUDS.	7136	Pahlavi – Astara,	〃	14	
〃	7137	〃	〃	14	
〃	7138	〃	〃	14	14
〃	7139	〃	〃	14	

Appended Table 1. (continued)

B. *racemosus* Huds.	7140	Pahlavi – Astara, Iran	14	
B. secalinus Linn.	7132	Pul-i-Khumri, Afghanistan	—	17
Cynodon dactylon (Linn.) Pers.	7321	Ramsar – Rasht, Iran	—	62
Cynosurus echinatus Linn.	7221	Astara – Ardabil, 〃	16	54
Dactylis glomerata Linn.	7211	Behshahr, 〃	28	
〃	7212	Sari – Behshahr, 〃	—	55
〃	7213	Ardabil – Sarab, 〃	—	
Elymus dahuricus Turcz.	7066	Hopar, Afghanistan	42	5
Eragrostis sp.	7202	Kandahar – Ghazni, 〃	—	63
Eremopyrum buonapartis (Spreng.) Nevski var. *buonapartis*	7033	Chaman, Pakistan	28	
〃	7035	Isfahan, Iran	14	35
〃	7036	Isfahan – Damaneh, 〃	28	36
〃	7038	Tabriz – Ardabil, 〃	28	37
〃	7042	Mashhad, 〃	28	38
〃	7043	Kandahar, Afghanistan	28	39
〃	7044	Kandahar – Ghazni, 〃	—	
E. buonapartis (Spreng.) Nevski var. *sublanuginosum* (Drob.) Melderis	7032	Quetta – Chaman, Pakistan	28	40
〃	7034	Kabul – Jalalabad, Afghanistan	28	41
E. distans (C. Koch) Nevski	7041	Pul-i-Khumri, 〃	14	42
E. orientale (Linn.) Jaub. *et* Spach.	7031	Quetta – Chaman, Pakistan	28	
〃	7037	Ardabil – Tabriz, Iran	28	43

. (continued)

	7181	Isfahan,	Iran	42			
	7182	Tehran – Sari,	〃	14	6		
	7183	Pahlavi – Astara,	〃	—	7		
s.) C. E. Hubbard var. *persica*	7331	Tehran – Ghazvin,	〃	14			
〃	7333	Ardabil – Tabriz,	〃	14	8		
〃	7338	Tabriz,	〃	—			
〃	7339	Dept. Agr., Tehran,	〃	14			82
〃	7340	〃	〃	—			
〃	7341	〃	〃	—			
. Hubbard *a* (Hausskn.) C. E. Hubbard	7334	Ardabil – Tabriz,	〃	14	9		
〃	7335	〃	〃	14			
〃	7336	〃	〃	—			
〃	7337	〃	〃	—			
m (Banks *et* Soland.) Hochst.	7051	Tehran,	〃	14	56		
〃	7052	Mahabad,	〃	14	57		
〃	7053	〃	〃	—			
〃	7054	〃	〃	—			
〃	7055	Pul-i-Khumri,	Afghanistan	14		32	75
.) Pers.	7191	〃	〃	—			
	7192	〃	〃	26	58		76
	7232	Pahlavi – Astara,	Iran	—			

Appended Table 1. (continued)

Paspalum distichum LINN.	7291	Rasht – Pahlavi,	Iran	—	64
Phalaris minor RETZ.	7271	Pul-i-Khumri,	Afghanistan	28	59
〃	7272	Tashkurgan – Aq Chah,	〃	—	
〃	7273	Kandahar,	〃	28	60
Phleum paniculatum HUDS.	7241	Behshahr – Gorgan,	Iran	—	
〃	7242	Tehran – Sari,	〃	—	
〃	7243	Astara,	〃	—	
〃	7244	〃	〃	—	65
〃	7245	Astara – Ardabil,	〃	—	
Polypogon monospeliensis (LINN.) DESF.	7251	Kandahar,	Afghanistan	28	61
Setaria verticillata (LINN.) P. BEAUV.	7281	Sari – Gorgan,	Iran	—	66
Sorghum halepense (LINN.) PERS.	7311	Kabul – Charikar,	Afghanistan	—	67
Taeniatherum asperum NEVSKI	7061	Hazar Ghanj,	Pakistan	—	
〃	7062	〃	〃	—	
〃	7063	〃	〃	—	
〃	7065	Pul-i-Khumri,	Afghanistan	14	21
T. crinitum (SCHREB.) NEVSKI	7064	Karaj,	Iran	14	22

Wild and cultivated varieties of barley from Afghanistan and its neighboring regions

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Introduction

Kyoto University Scientific Expedition (KUSE) to North Afghanistan and its neighboring regions brought back 49 samples of cultivated barley, together with 21 samples of wild barley, including *Hordeum spontaneum* C. KOCH. These were kindly provided to the writers for agrobotanical and genetical analyses.

The first botanical and agricultural survey of Afghanistan was made by a team of Russian agronomists, headed by N. I. VAVILOV. They visited there twice, in 1924 and 1926–27, and travelled through about 6,000 km, embracing almost the whole territory of agricultural Afghanistan. About ten years later, a German Expedition (DHE) again explored Afghanistan, the northern parts of India and Pakistan, and also a part of Iran. The barley samples collected by DHE amounted to as many as 538. The results of their studies on these materials were published by VAVILOV and BUKINICH (1929) and FREISLEBEN (1940), respectively.

According to VAVILOV and BUKINICH, Afghanistan is not so rich in forms of cultivated barley as it is in wheat, and can hardly be considered as the center of origin of any kind of cultivated barley. Although they have found that the Hindukush is the natural limit of distribution for *H. spontaneum*, a wild species closely akin to the two-rowed cultivated form, little attention has been paid to this fact. They are of opinion that *H. spontaneum* has played no part in the origin of cultivated forms. On the contrary, FREISLEBEN (1940) has taken an active interest in the facts found from his study on DHE materials, namely that the eastern boundary of distribution of the two-rowed cultivated forms is almost in accord with that of *H. spontaneum* and further that natural crossing between

KUSE made a botanical survey. Therfore, despite of little diversity in the morphological characteristics of cultivated barley as suggested by VAVILOV and BUKINICH, a detailed study of KUSE material may still give some useful information for the consideration of phylogeny or origin of cultivated barley.

With this in mind, the morphological and physiological characteristics of the barley materials collected by KUSE were studied. Emphasis was placed especially on such characteristics as are known to be peculiar to either of the two different geographical barley types.

Morphological characteristics and geographical distribution

1. Wild barley

Two wild species, *H. spontaneum* C. KOCH and *H. murinum* L., were included in the barley collections of KUSE. *H. spontaneum* is similar in many respects to some of the cultivated, two-rowed barley, such as *H. distichum* var. *nutans* and *nigricans*, and is readily crossed with the cultivated forms, resulting in fertile hybrids. It differs from the latter in such characteristics as spontaneous disarticulation of rachises, heavily dentated awns, densely haired empty glumes, and an extremely long period of seed dormancy. Five varieties were classified by ÅBERG (1940) based on color of head and awn, and awn length. These are known to be distributed widely in south-western Asia, ranging from North Afghanistan to Asia Minor and the Middle East, the straw-colored form being the most predominant.

Nine samples of this species were collected mostly from Afghanistan. Of these, six were of var. *ischnatherum* COSSON with straw-colored head and awn, and three of var. *transcaspicum* VAV. having black head and awn. All of them were of winter habit of growth, and mostly procumbent at their early growth stage; their leaf-sheaths were all hairless, and leaf-blades were mostly very narrow; awns were 13~15 cm long, rachilla long-haired and empty glumes covered with thick hairs, kernels were mostly thin having blue aleuron layers. However, KUSE 31 from Iran has somewhat broader leaves and kernels without anthocyanin in aleuron layers; its young plant is medium erect. There are also some forms having much

them regarding such characteristics as hairiness of empty glume surface and length of empty glume including its awn.

Besides these two wild species, Russian and German expeditions found the following six wild species distributed in this region: ***H. bulbosum*** L., ***H. crinitum*** Desf., ***H. secalinum*** Schred., ***H. caducum*** Munro., ***H. violaceum*** Bois. ***et*** Huet. and ***H. maritimum*** With.

2. Cultivated barley (*Hordeum vulgare L. s. l.*)

Forty-nine strains of cultivated barley of the KUSE collection were classified after the system proposed by Mansfeld (1950). The following conspicuous characters, mostly governed by major genes, were referred to: kernel row or development and fertility of lateral florets; covered and naked kernel; ear density or length of rachis-internodes; barbing of awns; color of caryopsis and awn caused by presence or absence of melanin-like substance (black and straw-color); blue and white aleuron layer of kernel. Names of varieties and their frequencies are shown

Table 1. Varieties of cultivated barley (*H. vulgare L. s. l.*) found in Afghanistan and Iran by KUSE, Vavilov and Bukinich, and DHE

Variety	KUSE	Vavilov *et al.*	DHE
hybernum Vib. (=***pallidum*** Sér.)	8	+	+
nigrum Link.	1	+	
nigripallidum R. Regel.			+
afghanicum Vav.		±	
rikotense Regel.		+	+
parallelum Körn.	2		+
pyramidatum Körn.			+
glabripyramidatum Vav.		+	
brevispicatum (Vav. ***et*** Orl.) Mans.[1]			±
coelesta L.	7	+	+
himalayense (Ritt.) Körn.		+	+
sublatiglumatum Körn.		+	

in Table 1, together with the varieties found by Russian and German expeditions in this region. In order to help understanding their diagnostic characteristics, a table was also prepared and is appended to the end of this paper (Appended Table 1).

As apparent in Table 1, KUSE collection of cultivated barley comprises only seven botanical varieties. About 80 per cent consists of six-rowed type (convar. *hexastichon*) and the remaining is two-rowed type (convar. *distichon*). Within the former group, var. *hybernum* is the most frequent. Seven strains are of naked type, all of which are very similar in appearance, belonging to a single variety, *coelesta*. Among the two-rowed barleys, three different varieties are distinguished, namely, *nutans, medicum* and *persicum*. Six out of the seven varieties listed in Table 1 have already been known to exist in this region, and only one form, *persicum*, which is characterized by two-rowed, black head and smooth awns, seems to be new to this region.

The place of collection of these seven varieties of cultivated barley and also the two varieties of *H. spontaneum* is shown in Fig. 1. The map indicates that

Fig. 1. Locality map of varieties of *H. spontaneum* and cultivated barley

possessed by the seven varieties collected by KUSE, and they seem to occur more or less commonly in this and its neighboring regions. However, two others are very curious in appearance and probably of no practical use. One is *afghanicum* VAV. which is characterized by a bracteate leaf at each ear-triplet, and the other *sublatiglumatum* KÖRN., a wide-glumed, six-rowed, naked form. VAVILOV and BUKINICH have pointed out that both might have arisen by mutation in the fairly recent past. It is now known that similar spontaneous and/or artificial mutations, especially of the latter type, have occurred fairly frequently (MIYAKE and IMAI 1922, TAKAHASHI *et al.* 1953, SCHOLZ u. LEHMANN 1958).

In the following the results of observation or measurement of several minor characters will be further presented, which may be of some use for disclosing characteristics of the barley distribution in this region. As is indicated in Table 1, Afghan and Iranian barleys are mostly long-awned forms, and so far as is known, include only one short-awned variety that was identified by FREISLEBEN as *brachyatherum* KÖRN., although its awn texture was different from the original description by KÖRNICKE. On the contrary, variation in barbing of awns is rather striking. In some strains awns are quite smooth on almost their whole length excepting their tips, but in several others fine teeth are distributed sparsely along both edges, but not on the basal part of the middle ridge of the awns. There are also a number of forms with slightly rough to medium rough awns. Moreover, some strains from North Afghanistan have considerably broad, coarse awns. It may be of some interest to note that Nepalese and Tibetan barleys are exclusively rough-awned ones, but are multifarious regarding shape and length of lemma appendages, which conditions are in sharp contrast to those recognized in KUSE barley materials.

Similarly, a wide variation is recognizable with regard to barbing of lemma veins, in spite of the fact that no close correlation seems to exist between the barbing of the awn and that of lemma veins. Some are quite smooth, some are very rough, and others intergrade between these two extremes, with semi-smooth to slightly rough types predominant.

A glance at Table 1 reveals that KUSE barleys are rather uniform regarding ear density, because almost all of them are of the lax-eared type. However, the length of the rachis internodes of these lax-eared forms vary widely from 3.1 to

Afghanistan and Iran. No specimen as such was found by KUSE, however.

Blue pigmentation in the aleuron layer of the barley kernel is a characteristic rather common in the world, though its frequency of occurrence varies considerably with plant types and geographical regions. Generally speaking, blue kernel is not so frequently met with in naked forms as in covered forms. A few naked strains from Charikar, Afghanistan and also from Kashmir appear to have kernels of a faintly bluish shade, but no plant type with typical, deeply pigmented kernels like var. *himalayense* RITTIG. is involved in the KUSE collection, whereas the latter form has frequently been found by foreign expeditions in the same regions. About one half of the covered barleys from Iran are characterized by blue aleuron, some being colored rather deeply, some moderately, and some others so faintly that the existence of anthocyanin in the aleuron layer can only be detected by staining a kernel section with diluted hydrochloric acid. On the other hand, Afghan covered barleys are all of white aleuron.

Presence of anthocyanin in various plant parts other than the aleuron layer results in reddish, but not blue, pigmentation. The majority of the barley strains in this region are colored in awn tips, lemma veins, auricles of the leaves, basal leaf-sheaths, etc. It was found, however, that several specimens lack pigment in any parts of their plant. Such a colorless form is rather rare, although it is known to occur frequently among Japanese naked barleys and Abyssinian covered barleys.

As was expected from the previous investigations (FREISLEBEN 1940, TAKAHASHI 1955), two rachilla types, long-haired and short-haired, are found to be differentiated among our materials. However, the short-haired type is less frequent than expected, and all the specimens from Iran are wholly of the long-haired type.

One of the writers (TAKAHASHI 1955) has pointed out the following geographical regularity of distribution of hairy and hairless conditions of leaf-sheath. With a few exceptions naked barleys are glabrous. In the covered barley, on the other hand, the relative frequency of hairy varieties is very high in southern Japan, and it decreases to some extent in southern Korea and China Proper, but westwards from there it becomes far lower, although hairy varieties are again frequently met with among the European winter barleys. Just as is expected from the above statement, almost all of the KUSE barleys are characterized by glabrous sheath,

rachises is known to be due to the presence of two complementary genes, *Bt* and Bt_2, while either or both of the recessive genes allelic to *Bt* and Bt_2 are responsible for the tough condition. It is expected therefore that among the cultivated barleys there are three kinds of genotypes, namely, $BtBtbt_2bt_2$ or type E, $btbtBt_2Bt_2$ or type W and $btbtbt_2bt_2$ or type we, although the last type is very rare probably because of close linkage of *bt* and bt_2 genes (TAKAHASHI *et al.* 1964).

Genotype analysis of all the cultivated forms was made in the following way: Each of the strains was crossed with two kinds of the known genotype analysers, one with genic constitution $BtBtbt_2bt_2$ (type E) and the other with $btbtBt_2Bt_2$ (type W). The resulting two kinds of hybrids, which may be expressed as F_1(E) and F_1(W), were grown in the field, and the brittleness or toughness of their rachises was tested at their maturity. This test enabled us to determine the genotypic constitution of each strain, because if F_1(W) is tough and F_1(E) brittle, the strain must be type W, if the relation is the reverse it must be type E, while type we strain must give no brittle F_1 hybrids.

As shown in Appended Table 3, the results indicate that the many of the strains are type E, and only eight are type W. No type we was found. Among the strains of type W six are two-rowed form. Six-rowed strains are mostly type E and only two are type W, one from Quetta and the other from Kabul.

2. Post-harvest dormancy of wild barley seed

Delayed germination after harvest or post-harvest dormancy is rather common in cereal seeds, and it is more pronounced in wild relatives than in the cultivated forms. A preliminary experiment was made to compare the degree of post-harvest dormancy of all the strains of *H. murinum* and *H. spontaneum* collected by KUSE. About one and a half months after harvest 50 seeds of each strain were taken and placed on moistened filter paper set in a Petri dish of 9 cm in diameter. Two of these make up a set. Germination temperature was adjusted as 30°C but often rose higher especially in day time. The final count of the germinated seeds was made 35 days after sowing. A summarized results are given in Table 2.

Table 2. Germination percentage of the seeds of *H. murinum* and *H. spontaneum* about one and a half months after harvest

The result explicitly indicates that, whereas a cultivated variety, Saga-tairyu No. 2, has completely awaken from dormancy at that time, the seeds of all the strains of wild species were still in a highly dormant condition. Mean germination percentage was only 28.8% for *H. murinum* and 25.1% for *H. spontaneum*. Their germination speed was mostly very slow, as only one or two seeds sprouted intermittently until the close of the test. The depth of dormancy seemed to be different to some extent among strains: some were so deep that only 5% of the seeds could germinated, while in some others more than half of the seeds germinated.

According to YAMAMOTO (1950) and TAKAHASHI (1938, unpublished), the period of dormancy seems to be somewhat shorter in cultivated barley than in wheat. On the contrary, an extremely high degree of dormancy was found to be inherent in some of the strains of *H. spontaneum*. Our preliminary experiment (unpublished) has indicated that germinability at 30°C was not improved at all by more than five months' after-ripening, though at room temperature (10~20°C) these seeds could germinate almost normally. It was further revealed that gibberellin treatment accompanied by exposure to low temperature was effective to some extent in forcing the germination of fresh seed of *H. spontaneum*, but still insufficient for the complete breaking of dormancy.

3. Reactions to some Japanese powdery mildew races

Studies on the reaction of barley varieties to various races of powdery mildew, *Erysiphe graminis hordei*, are of value not only for breeding resistant varieties but also for gaining knowledge of phylogenetic relations of cultivated barley. According to HIURA and HETA (1959), 940 barley varieties collected from all parts of the world were classified into 18 reaction groups based on their differential reactions to three Japanese physiological races, I, IV and IX, of barley mildew. The reactions of all the strains of the KUSE barley collection to powdery mildew were studied by inoculating with these three races I, IV and IX onto their seedlings. Five plants of each strain were used for each test, and these tests were repeated twice in a greenhouse. In this test the following criteria were employed for distinguishing infection types produced on the first leaf of the seedling.

R (resistant): No visible signs of infection, or no visible development of mycelium if necrotic spots present.

our world collection. One exception is strain No. 74 which was sorted as a mixed group, as it involved individuals exhibiting obviously different reactions to each of these races. Summarized results are shown in Table 3.

Table 3. Grouping of barley strains collected by KUSE based on their differential reactions to three Japanese physiological races, I, IV and IX, of barley mildew

Reaction to races***			Specimen number								Total
I	IV	IX									
S	S	S	26**	37	39	42	44	45	46	56	23
			57	60	61	70	71	75	76	77	
			78	79	85	86	87	88	89		
S	S	M	35	36	50	53	58	67	69	84	8
S	S	R	47	52	59	83					4
M	S	S	27**								1
M	S	M	54								1
M	S	R	33	55							2
M	M	S	31**								1
M	M	M	07*	13*	15*	24**	30**				5
M	M	R	34								1
R	S	S	38	41	82						3
R	S	M	66								1
R	S	R	51	68							2
R	M	R	80	81							2
R	R	M	72								1
R	R	R	06*	09*	11*	16*	17*	18*	20*	21*	14
			22**	25	28**	29**	32**	65*			
Mixed			74								1

*=*Hordeum murinum* L.

**=*Hordeum spontaneum* Koch.

*** S=Susceptible, M=Moderately resistant, R=Resistant.

tely resistant to race I and highly resistant to race IX. On the other hand, a remarkably wide range of variation is exhibited by Iranian barleys regarding the reaction types to these three races. Rather strange and hence interesting to us in this connection is the fact that the KUSE collection does not include any strains corresponding to the reaction groups, (R to I, M to IV, S to IX) and (R to I, R to IV, S to IX), whereas the former group or type has been found most frequently among European varieties (34%) and the latter has accounted for 20% of the Nepalese collection of barley.

When the same results obtained here are viewed from a somewhat different angle, some interesting facts or relationships may be pointed out. Namely, all but one naked barley strain are susceptible to all races, while three strains of the *persicum* type are all highly resistant to them. Furthermore, two-rowed barleys, excepting *persicum* type, are for the most part susceptible to all races, whereas *H. spontaneum*, a putative ancestor of two-rowed cultivated forms, are, as above stated, for the most part resistant to these three races.

4. Earliness and lateness in heading time

Relative earliness in the heading time of the KUSE barley collection was investigated under the growing conditions at Kurashiki, southern Japan. Following our conventional cultural method, seeds were simultaneously sown in row in mid-November, 1957. The time of heading of each strain was recorded when about 80 per cent of heads in each row of the strain had appeared from the sheaths. The

Table 4. Time of heading of the barley strains, both cultivated and wild, of KUSE collection. They were sown in mid-November, 1957, in the field at Kurashiki, southern Japan

Heading time / Region (Type)	April				May								Total
	18······24	26	28	30	2	4	6	8	10	12	14	16	
Kashmir (S=I, II)						1		3	1				5
Pakistan (S=I, II)			3*	1		1							5
Afghanistan (S=I, II)		1	1	2	2	3							9
{S (I, II)	3	2	1		1	3	3	2					15

result of observation is summarized and shown in Table 4.

It is obvious from the table that winter-type strains, both cultivated and wild, are somewhat later in general than spring-type ones. Average date of heading of Iranian cultivated, winter forms and that of *H. spontaneum* are as late as that of Iwate Omugi No. 3, one of the latest varieties of Japan, and *H. murinum* are apparently still later than above two groups. Among the spring-type strains, on the other hand, those originated from Kashmir are the latest, and Pakistani and Afghan spring barleys are somewhat earlier in general and almost in accord with Kobinkatagi, a mid-season variety of Japan. Iranian spring barleys seem to be subdivided clearly into early and late groups. Contrary to our expectation from the fact that these materials are originated from lower latitudinal regions, no strains which are very early in heading were involved.

The heading time of cultivated barley under outdoor conditions is an integrated character affected by both internal and external factors. As the important internal factors responsible for it, spring and winter habit of growth (vernalisation response), sensitivity of vernalised plant to short photoperiod (photoperiodic response) and to long photoperiod (earliness in a narrow sense) can now be stated. And, it has been demonstrated that, when sown outdoors in late fall under southern Japanese conditions, the heading time of cultivated barleys depends chiefly upon sensitivity to short photoperiod, but is almost indifferent to the grade of spring habit and also earliness in a narrow sense (TAKAHASHI and YASUDA 1957). A test was made to know whether these relations also held for wild barleys and further how far KUSE materials would be variable as regards sensitivity to short and long photoperiods. The materials used are all strains of wild barleys in our possession, including those of the KUSE collection. They were grown under 8, 12 and 24 hour illuminations respectively in a green house. Prior to sowing, slightly sprouted seeds had been exposed to low temperature (2~3°C) for vernalization, as all of these wild barleys were of winter habit.

Table 5 shows mean dates of flag-leaf emergence of *H. murinum* and *H. spontaneum* of the KUSE collection under 8, 12 and 24 hour photoperiods after verna-

Table 5. A comparison of *H. spontaneum* and *H. murinum* of KUSE collection with regard to mean date (in May) of heading under natural condition and

lization, together with mean dates of heading under outdoor conditions. This indicates that *H. spontaneum* is to some extent earlier under all four growing conditions than *H. murinum*. But, variability of the strains within each species in response to short and long days is rather small, and is not very different between the two species. It may be concluded therefore that the majority of the strains of *H. spontaneum* are less sensitive to the retarding effect of a short day on one hand, and more sensitive to the forcing effect of a long day than those of *H. murinum*.

Interrelationships of two inner factors (denoted as x_1 and x_2) with earliness under natural conditions (Y) were studied further using the data of 54 strains of wild barleys including the KUSE materials. The result shown in Table 6 indicates

Table 6. Interrelationships between heading time under outdoor condition (Y) and two physiological factors, responses to 12 hr. (x_2) and 24 hr. (x_1) photoperiods after vernalization. 54 wild barley strains were used as material.

	x_2 Response to 12 hr.	Y Outdoors	b′ Y on x′s
x_1 Response to 24 hr.	+0.524**	+0.621**	+0.277**
x_2 Response to 12 hr.		+0.800**	+0.655**

** R = +0.835

that both of the inner factors, earliness in a narrow sense (x_1) and photoperiodic response (x_2), always correlate to a considerable extent with earliness under natural conditions (Y). However, the standard partial regression coefficients of Y on x_1 and x_2 suggest that photoperiodic response is a more important inner factor that determines the earliness of wild barleys grown under natural condition than earliness in a narrow sense. This is almost the same result as that established with the cultivated barleys. Conversely, therefore, earlier heading of *H. spontaneum* than *H. murinum*, and also lateness of these wild barleys as a whole compared with some of the early Japanese cultivated barleys, may be explained plausibly on these bases.

5. Spring and winter habit of growth

field 9 times at intervals of 10 days from February 10 to May 20, and the critical time of sowing to permit normal heading was observed. 2) 20 or more plants of each strain were reared in a green house under 24 hour-day, and the time of heading was recorded. In both experiments a series of standard varieties of known grade of spring habit were grown at the same time in order to classify the strains being tested. The grade of spring habit thus determined was expressed by the conventional symbols, I, II, ... VI, where I stands for the highest and VI for the lowest degree of spring habit, respectively, as given in Appended Tables 2 and 3.

The result indicates that all of the wild barleys, belonging to *H. spontaneum* and *H. murinum* are winter type, ranking IV to V. In sharp contrast to this, the majority of the cultivated forms, in which almost all of the two-rowed ones are included, are of highly spring habit, being graded as I or II, and only 16 are ranked III or IV. No strain of highly winter habit was found. Nine out of the 16 winter barleys were those collected at Kerman, Isfahan and Shahr-Kord, central Iran, and 6 around Gorgan, Astara and Ardabil, located along the Caspian Sea coast and at Mashhad, northeastern Iran. This naturally suggests that in Iran barley is sown mostly in autumn. On the other hand, in Afghanistan and northern Pakistan, spring barleys only are distributed, and hence it may be supposed that spring growing is being chiefly practiced. According to VAVILOV and BUKINICH, naked and covered barleys are grown as the principal crop at an altitude from 2,000 up to 3,400 m in the mountainous regions.

6. Genotype differentiation among spring barleys

TAKAHASHI and YASUDA (1956), from their study on the inheritance of spring and winter habit with a large number of barley crosses, have drawn the following conclusion: At least three independent pairs of genes, designated as *Shsh*, Sh_2sh_2 and Sh_3sh_3, are responsible for the character pair. The genes, *sh*, Sh_2 and Sh_3, are responsible for spring habit and their allelomorphs for the winter habit. In other words, spring habit is recessive for the first pair, but is dominant for the second and third pairs. Further, both of the dominant spring genes, Sh_2 and Sh_3, are epistatic to the dominant winter gene, *Sh*, of the first pair, and the recessive spring gene, *sh*, is epistatic to sh_2 and sh_3 for the winter habit. As a natural consequence it follows that only those plants with a genotype, $Shsh_2sh_3$, are of winter habit,

stitutions. The accession number of the spring barleys tested and their plant types and origin are shown in Table 7. Eight of them are those collected by KUSE and

Table 7. Spring barleys tested for their genetic constitutions, and winter barleys mated

Spring barley tested**			Winter barley mated	
No.	Varietal name	Locality	Name	Leaf-sheath
33	*coelesta*	Quetta, Pakistan	Hayakiso No. 2	hairy
35	*hybernum*	Chaman, 〃	〃	〃
36	〃	〃 〃	〃	〃
H. E. 3649	*freislebenii*	Lyallpur, 〃	Sakigake	〃
〃	〃	〃 〃	Shimabara	〃
〃	〃	〃 〃	Shimabara × Mensury C*	hairless
41	*hybernum*	Kabul, Afghanistan	Zairai Rokkaku	hairless
Kabul 1	〃	〃 〃	Hayakiso No. 2	hairy
Kabul 3	〃	〃 〃	〃	〃
45	*coelesta*	Charikar, 〃	〃	〃
60	*medicum*	Tehran, Iran	Zairai Rokkaku	hairless
61	〃	〃 〃	Hayakiso No. 2	hairy
79	*nutans*	Sarab-Ardabil, 〃	〃	〃
83	*hybernum*	Shahpur, 〃	Sakigake	〃

* A spring variety with genotype, $shsh_2sh_3$.

** All the spring barley have glabrous sheath.

two were received from Dr. SUZUKA who visited Pakistan and Afghanistan. H. E. 3649 is one of the DHE collection, obtained at the Agricultural Experiment Station in Lyallpur, Pakistan. FREISLEBEN supposed that this might come from India. These spring barleys were each crossed with a winter barley listed in Table 7.

distribution of F_2 plants regarding date of heading represented a completely interrupted bi-modal curve, and coincidence in heading period was recognized between

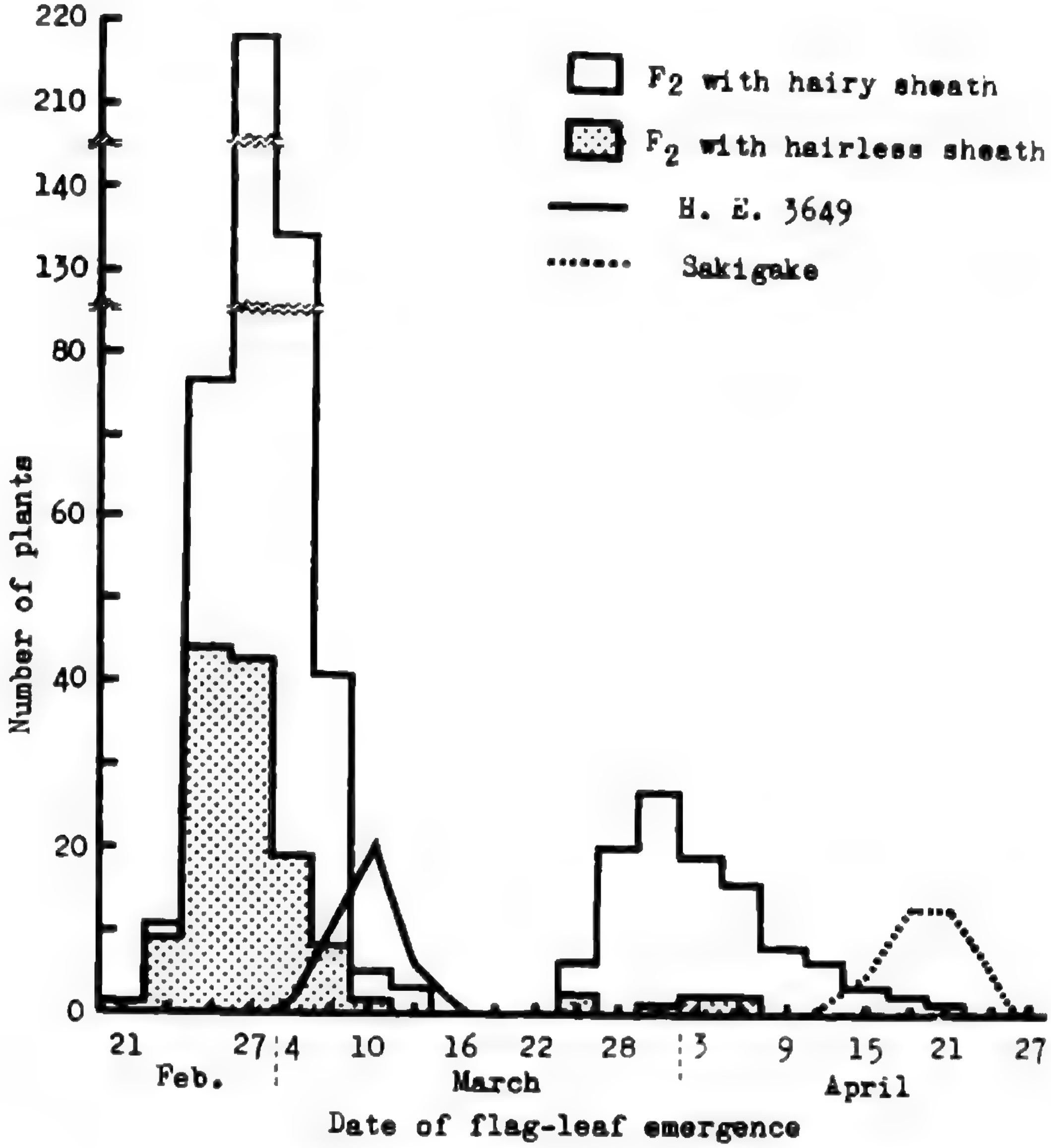

Fig. 2. Date of flag-leaf emergence of the F_2 plants from a cross between H. E. 3649 and Sakigake, and of their parents, grown under continuous illumination in a glass house

the early group and the spring type parent on one hand and between the late one and the winter type parent, on the other. Segregation of spring vs. winter types in F_2 of the 14 crosses was determined in this way, and the results were presented mostly in relation to hairy vs. nonhairy character segregation in Table 8 A and B.

Let us first examine the results of the two crosses with strains Nos. 60 and

Table 8. Segregation of spring and winter types in F_2 of 13 crosses, and their relation to the sheath-hair character pairs

(A) Varietal groups with one spring gene.

Cross*	Item	Spring type		Winter type		Total	χ^2
		Hairy	Hairless	Hairy	Hairless		
(1) Single recessive group:							
60 × Z. R.	Observed	81		217		298	
	Calculated as 1 : 3 ratio	74. 5		223. 5		298	0. 75
61 × H.	Observed	4	56	144	11	215	
	Calculated as *sh-hs* 6.1% of recombination	6. 23	59. 16	141. 67	7. 94	215	2. 18
(2) Single dominant group:							
33 × H.	Observed	166	52	59	22	299	
	Calculated as 9 : 3 : 3 : 1	168. 19	56. 06	56. 06	18. 69	299	1. 06
35 × H.	Observed	166	58	53	21	298	
	Calculated as 9 : 3 : 3 : 1	167. 60	55. 90	55. 90	18. 60	298	0. 55
36 × H.	Observed	145	71	58	24	298	
	Calculated as 9 : 3 : 3 : 1	167. 60	55. 90	55. 90	18. 60	298	8. 77
41 × Z. R.	Observed	201		88		289	
	Calculated as 3 : 1	216. 75		72. 25		289	4. 57
Kabul 1×H.	Observed	66	17	29	9	121	
	Calculated as 9 : 3 : 3 : 1	68. 00	22. 60	22. 60	7. 60	121	3. 51
Kabul 3×H.	Observed	163	67	59	17	306	
	Calculated as 9 : 3 : 3 : 1	172. 00	57. 40	57. 40	19. 20	306	2. 37

* Z. R. and H. stand for Zairai Rokkaku and Hayakiso No. 2, respectively.

Table 8. (Contuned)

(B) Varietal groups with two or three spring genes.

Cross*	Item	Spring type		Winter type		Total	χ^2
		Hairy	Hairless	Hairy	Hairless		
(3) Digenic variety :							
H. E. 3649 × S. G.	Observed	365	125	101	7	598	
	Calculated as *sh-hs* 11.5% of recombination	344. 48	141. 40	104. 02	8. 10	598	3. 36
H. E. 3649 × S. B.	Observed	322	130	106	8	566	
	Calculated as *sh-hs* 11.3% of recombination	325. 92	133. 96	98. 58	7. 54	566	0. 75
(H. E. 3649 × S. B.) × M. C.	Observed	55	72	39	4	170	
	Calculated as *sh-hs* 11.3% of recombination	47. 30	80. 20	37. 70	4. 80	170	2. 27
(4) Double dominant or trigenic group :							
45 × H.	Observed	120	37	7	1	165	
	Calculated as 45 : 15 : 3 : 1	116. 02	38. 67	10. 31		165	0. 72
	Calc. as *sh-hs* 6.4% of recomb.	116. 33	40. 93	7. 74		165	0. 50
79 × H.	Observed	201	69	15	5	290	
	Calculated as 45 : 15 : 3 : 1	203. 91	67. 97	13. 59	4. 53	290	0. 25
	Calc. as *sh-hs* 6.4% of recomb.	204. 47	71. 94	13. 03	0. 56	290	(35. 67
83 × S. G.	Observed	281		20		301	
	Calculated as 15 : 1	282. 19		18. 81		301	0. 08
	Calculated as 61 : 3	286. 86		14. 11		301	2. 57

* S. G., S. B., H. and M. C. stand for Sakigake, Shimabara, Hayakiso No. 2 and Mensury C, respectively.

product method was 6.1%, which closely approximated the value, 6.4%, found often in other previous experiments.

The following six strains, all originated from Pakistan and Afghanistan, seem to form a group with a common genotype for their spring habit: namely, strains 33, 35, 36, 41, Kabul 1 and 3. In the F_2 of the six crosses with these spring barleys, spring and winter types segregated in a 3 : 1 ratio. The observed number of the two types in these six crosses fitted well to the calculated ratio on the basis of a single dominant gene for the spring habit, but not to a 13 : 3 segregation ratio. No sign of linkage between spring vs. winter habit and sheath hair character pair was exhibited. Therefore, the genotype involved in these strains may be either $(Sh)Sh_2(sh_3)$ or $(Shsh_2)Sh_3$.

The third genotype was represented by H. E. 3649. In the F_2's of the two crosses, one with Sakigake and the other with Shimabara, spring and winter types segregated in a 13 : 3 ratio, indicating one dominant and one recessive spring genes having been involved in the crosses. And, the data for the inter-relation of spring vs. winter habit and hairy vs. non-hairy character pairs, shown in Table 8 B, suggested linkage of the genes for the characters. The recombination value calculated on the assumption of linkage between the recessive spring gene and non-hairy sheath gene was found to be 11.5 and 11.3%. Whether the recessive spring gene in H. E. 3649 be identical with *sh* in Mensury C was tested by a triple cross, F_1 (H. E. 3649 × Shimabara) × Mensury C. Segregation of spring and winter types in the cross was occurred in a 3 : 1 ratio, but not in a 1 : 1 ratio, which indicated obviously that H. E. 3649 involved the same recessive gene as in Mensury C. It was further established that the dominant spring gene, Sh_2, in the same strain was located at a distance of 13.07% from the gene *Rr* for rough vs. smooth awn and on the opposite side of *Ss* for long vs. short-haired rachilla, all being on chromosome 7. The detailed data will be presented in another paper.

Finally, the results of the remaining three crosses with Nos. 45, 79 and 83 will be stated. As seen in Table 8 B, the winter type plants segregated in these were much less than the spring type ones, which was presumably due to at least two dominant spring genes being involved. The agreement of these data with the expected 15 : 1 ratio was good. However, there is another posibility that one more recessive spring genes *sh* may be involved, for the segregation ratio of

Discussion

It is sure that a large number of characteristics or genes involved in cultivated barley have newly arisen independently one after another under cultivation on different occasions and in different places. From this, we may think that the geographical distribution of these genes may be haphazard. Despite this, an extensive study by VAVILOV (1926) has revealed a geographical regularity in their distribution, which has led him to a hypothesis that cultivated barley now grown in the world might have been derived from two gene centers, one in Abyssinia and Erythrea and the other in south-eastern Asia. Based chiefly on the study of DHE materials, FREISLEBEN (1940 a, b) has inferred that six-rowed wild barley was first domesticated somewhere in East Asia and the descendants had gradually spread all over the Old World. Entering in the regions west of Afghanistan, natural crosses with *H. spontaneum* had occurred frequently, resulting in two-rowed cultivated forms and some others, which had spread further westwards and southwards. TAKAHASHI has accumulated further knowledge about the gene or character distribution. According to him (1955), barleys found in the "Oriental" region, including northern Nepal, Tibet, China Proper, southern parts of Korea and Japan, have characteristics or genes quite different from those possessed by barleys in the remaining parts of the Old World or "Occidental" region. The genes and characters confined to the respective regions are given in Table 9.

It is also notable that the Oriental barleys wholly consist of the six-rowed form with a gene, bt_2, for tough rachis, and that naked kernel commonly occurs

Table 9. Genes and characters confined to the respective regions

Oriental region		Occidental region	
Gene	Character	Gene	Character
lr	reduced lateral awns	*V*, V^d	two-row
lk	short, fine awn	*Ml's*	resistant to midew race 1
K, K^e	hooded awn	*bt*	tough rachis

in the Oriental region, but is far less frequent in the Occidental region.

When we regard the results of this investigation in the light of the above facts, it is possible to consider that the whole region where KUSE has explored may be within the limits of the Occidental barley region, because, barleys in this region involve some genes characterizing the Occidental barley, such as *V*, *bt*, *s*, *r*, *sh*, etc., but not any one of those endemic to the Oriental region. However, we should realize that this explains only the barest outline of the situation, and hence a closer examination of the results is necessary.

First, it is noticed that barley strains from Kashmir, Pakistan and northern Afghanistan chiefly consist of six-rowed barleys of type E, which are susceptible to mildew races I and IV. Spring barleys there seem to be mostly single dominant type ($ShSh_2sh_3$). Moreover, naked barleys are fairly frequently met with. Since these characteristics or genotypes are very common among Oriental barleys, but are not so frequently found in the Occidental region, we cannot exclude the possibility that most of them might have been introduced into these regions from the East. However, at least four out of the eight strains from Kabul, Afghanistan and Quetta, Pakistan, are apparently exceptions. They are characterized by two-rowed head, resistance to mildew races I and IV, *bt* gene for non-brittleness of rachis, and short-haired rachilla, all of which are the characteristics of the Occidental type. It is dificult to ascertain whether these latter are endemic to these regions or have recently come from the West.

The situation for Iranian barleys is somewhat different from the above. Not a few two-rowed forms occur in this region. Some are resistant to mildew races, I and IV, as well as IX. There are also some forms of type W. Thus, more than half of Iranian barleys are possessed of some of the characteristics endemic to the Occidental type, and in this sense Iran may possibly be included in Occidental barley region.

However, the above statement does not necessarily imply that barley forms in these regions are similar to those found in other parts of the Occidental region. On the contrary, considerable differences are recognizable with respect to genotypic constitutions and especially frequencies of the genes endemic to the Occidental region. It is first pointed out that two-rowed forms are only one fifth of the samples collected in this region, whereas more than two thirds of the barley

Table 10. Frequency of susceptible, moderately resistant and highly resistant varieties or strains to three Japanese physiological races of powdery mildew in different regions

Material	Race I			Race IV			Race IX		
	S*	M	R	S	M	R	S	M	R
KUSE cultivated vars.	71	8	21	90	6	4	52	23	25
Japanese & Chinese vars.	91.5	6	2.5	96	4	0	43	57	0
European varieties	23	31	46	40	54	6	80	17	3

* S=Susceptible, M=Moderately resistant, R=Highly resistant.

its neighboring regions. As shown in Table 10, more than 90 per cent of the barley varieties from southern Japan and China Proper (Oriental type) are susceptible to races I and IV, but 57 per cent of them are moderately resistant to race IX. In contrast, the majority of the barleys from Europe (Occidental type) are highly or moderately resistant to races, I and IV, but as many as 80 per cent of them are susceptible to race IX. It is of interest to note that as high as 25 per cent of the cultivated forms of the KUSE collection are resistant to race IX, although they are similar to the Oriental barleys in their reaction to race IV and between Oriental and Occidental ones regarding the reaction to race I.

Diversity of the genes or genotypes related to some physiological characters may constitute another feature of KUSE barleys. As shown in Table 3, 49 strains of cultivated forms are differentiated into as many as 11 reaction groups which represent most of 18 groups that have been found in the test with more than 1,000 barley samples randomly taken from the world-wide collection of our institute. It is also noteworthy that this region is rich in genes or genotypes for spring habit. All kinds of spring genes, such as *sh*, Sh_2 and Sh_3, were shown to exist. Also, four or more types of spring barleys differing in combination of these genes were demonstrated to be present in this region, although the genotype analysis has not yet been completed.

The physiological difference between *H. spontaneum* and the cultivated forms distributed in the same region may deserve a brief mention. Two-rowed cultivated barleys in this and other parts of the world are mostly of spring habit, while

Summary

Kyoto University Scientific Expedition (KUSE) made a botanical survey of Iran, North Afghanistan and a part of Pakistan and Kashmir, and collected 49 samples of cultivated barley and 21 samples of wild barleys, including *Hordeum spontaneum* KOCH and *H. murinum* L. Their morphological, physiological and genetical characteristics are described in this paper.

As pointed out by VAVILOV and BUKINICH (1929), the cultivated barleys in these regions are not very diversified and only seven botanical varieties have been distinguished among them. Geographical distribution of the varieties of these cultivated barleys and *H. spontaneum* were as shown in Fig. 1. Since it was found that the cultivated barleys involved several kinds of the genes or characteristics peculiar to "Occidental type of barley", such as two-rowed head, short-haired rachilla, smooth awn, a recessive gene for spring habit, or *bt* gene for tough rachis, etc., but no single one of those peculiar to "Oriental type", it could be stated that the whole region where KUSE explored was within the Occidental barley region. However, these specific genes occurred in these regions considerably less frequently than in other parts of the Occidental region. The regions east of Afghanistan, inclusive, in particular, were chiefly occupied by such barley forms as are rather common in the Oriental but not in the Occidental region. It was also noticed that these regions were rich in the genotypes for spring habit and also those resistant to Japanese physiological races of mildew. These facts may suggest the co-existence of both regional barley types in these regions.

It was found that *H. spontaneum* and *H. murinum* were less variable than the cultivated form regarding various morphological and physiological characteristics. They are all winter type, late in heading, and resistant to Japanese mildew races, I, IV and IX. Their post-harvest dormancy of seed was remarkable. There was also little similarity in these physiological characteristics even with two-rowed cultivated barleys found in the same region.

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Appended Table 1. An abstract from MANSFELD's morphological system of cultivated barley, for indicating characteristics of the varieties found in and around Afghanistan

I. Convar. ***hexastichon*** ALEF. s. l. Many-rowed barley

1a. Kernel covered

2a. Ear lax, rachis-internode longer than 2.8 mm

3a. Empty glume narrow, breadth less than 1 mm

4a. Ear yellow

5a. Awn rough, long

6a. Ear with a bracteate leaf under each of middle spikelet

Appended Table 1 (Continued)

4c. Ear black to black-grey

5a. Awn rough, yellow

5. var. ***nigripallidum*** R. REGEL

5b. Awn rough, black

6. var. ***nigrum*** (WILLD.) LINK

2b. Ear medium dense, rachis-internode 2.2 mm–2.8 mm, empty glume narrow, ear yellow, awn long and rough

7. var. ***parallelum*** KÖRN.

2c. Ear very dense, rachis-internode less than 2.2 mm, empty glume narrow, ear yellow

3a. Awn long, rough

8. var. ***densum*** SÉR. (***pyramidatum*** KÖRN.)

3b. Awn long, smooth

9. var. ***glabripyramidatum*** VAV.

3c. Awn shorter than ear length, soft, thin, rough

10. var. ***brachyatherum*** KÖRN.

1b. Kernel naked

2a. Ear lax, rachis-internode longer than 2.8 mm

3a. Empty glume narrow, less than 1 mm

4a. Ear yellow, awn rough, long

5a. Kernel yellow to dark yellow

11. var. ***coelesta*** L.

5b. Kernel blue-green

12. var. ***himalayense*** (RITT.) KÖRN.

3b. Empty glume wide, ear yellow, awn rough, long, kernel yellow

13. var. ***sublatiglumatum*** KÖRN.

II. Convar. ***distichon*** ALEF. Two-rowed barley

1a. Kernel covered

2a. Ear lax, rachis-internode longer than 2.8 mm

3a. Empty glume narrow, breadth less than 1 mm

4a. Ear yellow

5a. Awn rough, long

14. var. ***nutans*** (RODE) ALEF.

5b. Awn smooth

15. var. ***medicum*** KÖRN.

Appended Table 2. Characteristics of wild barleys, *H. murinum* and H. *spontaneum*

Strain No.	Chaff color	Sheath hair	Lemma* teeth	Heading date outdoors (May)	Spring habit grade	Germination % (1½ month)	Reaction to mildew I	IV	IX	Remarks
L.										
06	yellow	no	SS	12	IV	32	R	R	R	
07	brown	〃	SS	7	IV	36	M	M	M	
09	〃	〃	S–SS	6	(w)**	50	R	R	R	
11	〃	〃	SS	10	(w)	26	R	R	R	
13	yellow	〃	SS	10	V	44	M	M	M	
15	〃	〃	S–SS	16	V	22	M	M	M	
65	brown	hairy	R–SS	13	(w)	5	R	R	R	
16	〃	〃	R	20	(w)	7	R	R	R	
17	brown-black	〃	R	10	(w)	6	R	R	R	
18	brown	〃	R	10	(w)	24	R	R	R	
20	yellow	no	S–SS	17	(w)	32	R	R	R	
21	〃	〃	SS	13	V	65	R	R	R	
m C. Koch.										
22	black	no	R–SS	9	V	37	R	R	R	
24	yellow	〃	S	11	IV	7	M	M	M	Awn-middle ridge smooth
26	black	〃	R	6	(w)	25	S	S	S	
27	yellow	〃	R	7	(w)	21	M	S	S	Leaves broad
28	black	〃	R	30/Apr.	(w)	41	R	R	R	
29	yellow	〃	R–VR	1	IV	18	R	R	R	Leaves broad
30	〃	〃	R–VR	6	(w)	13	M	M	M	
31	〃	〃	R	9	V	37	M	M	S	Aleuron white; leaf broad
32	〃	〃	R	11	IV	27	R	R	R	Aleuron light-blue

–Smooth, R=Rough, VR=Very Rough.

Appended Table 3. Characteristics of cultivated barleys

ain o.	Variety name	Ear density* (mm)	Aleuron color	Rachilla hair	Lemma teeth	Empty glume Length (mm)	Empty glume Hairiness	Rachis types	Reaction to mildew I	Reaction to mildew IV	Reaction to mildew IX	Spring habit grade	Heading date
5	*hybernum*	3.9	yellow	short	R	13	band	E	S	S	S	II	4/V
6	*coelesta*	3.1	light-blue	long	SS	14	line	E	S	S	S	II	7/V
7	*hybernum*	4.2	yellow	short	SS–R	14	none	E	S	S	S	II	7/V
8	*coelesta*	3.3	light-blue	long	S	15	line	E	S	S	S	I	8/V
9	〃	3.5	yellow	〃	R	17	band	E	S	S	S	I	7/V
7	*hybernum*	3.2	yellow	long	SS–R	14	line	E	S	S	S	I	26/IV
8	*parallelum*	2.4	〃	〃	S	17	covered	E	R	S	S	I	30/IV
9	*hybernum*	4.3	〃	short	R	21	line	W	S	S	S	II	1/V
1	〃	3.1	〃	long	S	16	band	E	R	S	S	I	3/V
2	〃	3.4	〃	〃	SS–R	14	line	E	S	S	S	I	29/IV
4	*coelesta*	3.2	〃	〃	R	19	band	E	S	S	S	II	4/V
5	〃	3.3	light-blue	〃	R	17	line	E	S	S	S	II	1/V
6	〃	3.1	〃	〃	R	21	covered	E	S	S	S	I	4/V
7	*hybernum*	4.0	yellow	〃	SS–R	13	〃	E	S	S	R	II	28/IV
5	*persicum*	3.3	yellow	short	VR	11	line	W	R	R	R	III	28/IV
3	*coelesta*	3.5	〃	long	R	21	〃	E	M	S	R	I	4/V

Appended Table 3. (Continued)

Quetta	34	*hybernum*	3.9	yellow	short	SS–R	18	line	W	M	M
Chaman	35	〃	3.6	〃	long	SS	16	〃	E	S	S
〃	36	〃	3.1	〃	〃	SS	16	〃	E	S	S
D. Iran											
Gorgan	66	*hybernum*	4.1	dark-blue	long	VR	13	band	E	R	S
〃	67	〃	4.1	blue	〃	R	10	〃	E	M	S
Mashhad	68	〃	2.9	〃	〃	SS	21	line	E	R	S
Firuzkuh	69	〃	4.1	dark-blue	〃	SS	14	〃	E	S	S
〃	70	〃	4.4	yellow	〃	SS	13	〃	E	S	S
〃	71	〃	4.1	light-blue	〃	SS	11	〃	E	S	S
Kerman	84	*parallelum*	2.5	yellow	〃	R	11	band	E	S	S
Isfahan	50	*hybernum*	3.8	light-blue	〃	R	20	〃	E	S	S
〃	51	*nigrum*	3.3	yellow	〃	R	19	covered	E	R	S
〃	52	*hybernum*	3.7	blue	〃	R	16	line	E	S	S
Demaneh	53	〃	3.4	yellow	〃	SS	18	〃	E	R	R
〃	54	〃	4.4	〃	〃	SS	16	〃	E	M	S
〃	57	〃	3.7	light-blue	〃	SS	17	〃	E	S	S
〃	58	〃	3.6	yellow	〃	R	18	〃	E	S	S
〃	59	〃	3.7	〃	〃	SS	20	〃	E	S	S
Shahr-Kord	55	〃	4.2	light-blue	〃	SS	20	〃	E	M	S
〃	56	*nutans*	3.7	yellow	〃	S	10	〃	W	S	S

Appended Table 3. (Continued)

Ghazvin–Tehran	60	*medicum*	3.4	yellow	long	R	10	band	W	S	S	S
〃	61	〃	3.2	〃	〃	R	9	〃	W	S	S	S
Astara–Ardabil	72	*hybernum*	3.4	blue	〃	VR	12	〃	E	R	R	M
〃	74	〃	4.1	〃	〃	VR	12	line	E	mixed		
〃	75	*nutans*	3.6	yellow	〃	S	9	band	W	S	S	S
Sarab–Ardabil	76	〃	3.6	〃	〃	S	10	line	E	S	S	S
〃	77	〃	3.7	〃	〃	S	11	〃	E	S	S	S
〃	78	*hybernum*	3.7	〃	〃	SS	13	〃	E	S	S	S
〃	79	*nutans*	3.5	〃	〃	S	11	〃	E	S	S	S
〃	80	*persicum*	3.3	light-blue	〃	SS–R	11	〃	E	R	M	E
Shahpur	82	*nutans*	3.1	yellow	〃	SS–R	9	〃	W	R	S	S
〃	83	*hybernum*	3.8	〃	〃	SS	12	〃	E	S	S	E
Mahabad–Tabriz	81	*persicum*	3.4	blue	〃	SS	10	〃	E	R	M	E

* Average internode length of rachis.

Wild and cultivated oats in southwestern Asia[1)]

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It is generally accepted that the hexaploid species of *Avena* including cultivated oats have their origin in southwestern Asia or Asia Minor (MALZEW 1930). New information concerning *Avena* species in this area is valuable for the study of the phylogeny and genetics of oats.

In 1955, seed samples of *Avena* were collected in the area from Karakoram to Hindukush by the members of the Kyoto University Scientific Expedition (directed by Dr. H. KIHARA). The collection has been maintained in Kyoto University as a gene source for the genetic study and breeding of oats. The morphology and classification of this material are described in this paper.

Classification of *Avena* has been attempted by many authors and several taxonomic schemes are now available (THELLUNG 1911, TRABUT 1914, ZADE 1918, MALZEW 1930, STANTON 1955). MALZEW (1930) made an extensive study on the phylogenetic and taxonomic relationships between wild and cultivated plants of the section *Euavena* on the basis of morphological characters and geographical distribution with little consideration of polyploidy. Cultivated forms, hulled and naked, are included by him as subspecies or proles into a wild species from which they might have been derived. His taxonomic scheme is still supported by a few investigators. In the present work a modification of MALZEW's system was adopted for the classification as shown in Table 1, because it was desirable for this study to accept most of the species names recognized by the majority of previous investigators.

Classification and characteristics of the collected material

Table 1. List of the corresponding species names used by the present authors and Malzew (1930)

Nishiyama and Teramura	Malzew (1930)
A. fatua L.	*A. fatua* L.
subsp. *septentrionalis* Malz.	subsp. *septentrionalis* Malz.
subsp. *meridionalis* Malz.	subsp. *meridionalis* Malz.
subsp. *fatua* (L.) Thell.	subsp. *fatua* (L.) Thell.
subsp. *cultiformis* Malz.	subsp. *cultiformis* Malz.
A. sterilis L.	*A. sterilis* L.
subsp. *trichophylla* (C. Koch) Malz.	subsp. *trichophylla* (C. Koch) Malz.
subsp. *macrocarpa* (Mönch) Briq.	subsp. *macrocarpa* (Mönch) Briq.
subsp. *ludoviciana* (Dur.) Gill. *et* Mag.	subsp. *ludoviciana* (Dur.) Gill. *et* Mag.
A. sativa L.	*A. fatua* L.
subsp. *nodipilosa* (Malz.)	subsp. *nodipilosa* Malz.
subsp. *macrantha* (Hackel)	subsp. *macrantha* (Hackel) Malz.
subsp. *sativa* (L.)	subsp. *sativa* (L.) Malz.
subsp. *praegravis* (Krause)	subsp. *praegravis* (Krause) Malz.
A. byzantina C. Koch	*A. sterilis* L.
subsp. *nodipubescens* (Malz.)	subsp. *nodipubescens* Malz.
subsp. *byzantina* (C. Koch)	subsp. *byzantina* (C. Koch) Malz.
subsp. *pseudo-sativa* (Thell.)	subsp. *pseudo-sativa* (Thell.) Malz.
A. nuda L.	*A. fatua* L.
subsp. *decorticata* (Malz.)	subsp. *nodipilosa* Malz. prol. *decorticata* Malz.
subsp. *nuda* (L.)	subsp. *macrantha* (Hackel) Malz. prol. *nudata* Malz.
subsp. *chinensis* (Fisch.)	subsp. *sativa* (L.) Malz. prol. *chinensis*

Cytological observations showed that the meiosis was normal in all the plants showing 21 bivalent chromosomes at the first metaphase, except in Stock No. 1081 with occasional two or four univalents and in Stock No. 1085 with 21 bivalents plus a chromosome fragment. The seed fertility was also good in all the plants.

The material was classified into three different species, *Avena fatua*, *A. sativa* and *A. sterilis*, and further into their subspecies or varieties as given in Table 2.

The descriptions of most plant characters were made after the standards used by STANTON (1955). The standards of classification used for some characteristics are given in the following:

Length of culm: (1) short (50 cm or less), (2) medium (51～100 cm) and (3)

Table 2. List of the *Avena* plants collected in Pakistan, Afghanistan and Iran

Species and variety	Stock No.	Collect. No.	Locality	
Avena fatua subsp. *septentrionalis* var. *valde-pilosa* MALZ.	1075	K6- 6- 1	Ghazni,	Afghanistan
Avena fatua subsp. *fatua* var. *pilosissima* S. F. GRAY	1074	K5-27- 5	Quetta,	Pakistan
〃	1077	K6-28- 1a	Isfahan,	Iran
〃	1078	K6-28- 1b	〃	〃
〃	1079	K6-28-11	〃	〃
〃	1085	K7- 1- 3d	Gorgan,	〃
〃	1086	K7-19- 8	〃	〃
〃	1087	K7-28-14	Tabriz,	〃
〃	1092	K7-24-11	Pahlavi,	〃
Avena fatua subsp. *fatua* var. *intermedia* (LES.) LEJ. *et* COURT.	1091	N5- 8-21	Minapin,	Pakistan
Avena sativa subsp. *nodipilosa* var. *glabra* (MALZ.)	1088	Y6-26- 2	Pul-i-Khumri,	Afghanistan
Avena sativa subsp. *sativa* var. *glaberrima*	1090	Y7- 9- 1	Mashhad,	Iran

long (101 cm or more)

Thickness of culm: (1) thin (0.5 cm or less), (2) medium (0.6~1.0 cm), and (3) thick (1.1 cm or more)

Length of leaf blade: (1) short (20 cm or less), (2) medium (21~40 cm), and (3) long (41 cm or more)

Width of leaf blade: (1) narrow (1.0 cm or less), (2) medium (1.1~2.0 cm), and (3) wide (2.1 cm or more)

Date of first heading: (1) early (mid-May or earlier), (2) medium (late May), and (3) late (early June or later)

Date of maturity: (1) early (mid-June or earlier), (2) medium (late June), and (3) late (early July or later)

Length of panicle: (1) short (20 cm or less), (2) medium (21~40 cm), and (3) long (41 cm or more)

Length of empty glume: (1) short (2.5 cm or less), (2) medium (2.6~3.0 cm), and (3) long (3.1 cm or more)

Width of empty glume: (1) narrow (*ca.* 0.6 cm), medium (*ca.* 0.8 cm), and wide (*ca.* 1.0 cm)

Length of floret: (1) short (2.0 cm or less), (2) medium (2.1~2.5 cm), and (3) long (2.6 cm or more)

Length of awn: (1) short (0.6 to 2.0 cm), (2) medium (2.1~4.0 cm), and (3) long (4.1 cm or more)

Length of hairs on lemma and rachilla segment: (1) short (*ca.* 0.1cm), (2) medium (*ca.* 0.3 cm), and (3) long (*ca.* 0.5 cm)

Length of scars (callus): (1) short (*ca.* 0.1 cm), (2) medium (*ca.* 0.2 cm), and (3) long (*ca.* 0.3 cm)

Length of caryopsis: (1) short (*ca.* 0.7 cm), (2) medium (*ca.* 1.0 cm), and (3) long (*ca.* 1.3 cm)

Thickness of caryopsis: (1) thin (*ca.* 0.1 cm), (2) medium (*ca.* 0.2 cm), and (3) thick (*ca.* 0.3 cm)

Length of rachilla segment: (1) short (*ca.* 0.1 cm), (2) medium (*ca.* 0.3 cm), (3) long (*ca.* 0.5 cm), and (4) extra-long (*ca.* 0.7 cm or more)

1. *Avena fatua* subsp. *septentrionalis* var. *valdepilosa* Malzew

Stock No. 1075, collected in Afghanistan

slender; lemmas gray, apical parts 2-toothed, dorsal parts glabrous, awned [medium to long (2.5 to 4.5 cm) and geniculate awns], basal parts hairy [numerous and medium-long (*ca*. 0.3 cm) hairs]; scars medium-long (*ca*. 0.3 cm), round; paleas gray, tight; caryopses medium-long (*ca*. 1.0 cm), slender, thin (*ca*. 0.1 cm), hulled; second floret rachilla segments medium-long (*ca*. 0.3 cm), hairy [long (*ca*. 0.5 cm) hairs].

2. *Avena fatua* subsp. *fatua* var. *pilosissima* S. F. GRAY

The eight samples, Stock Nos. 1074, 1077, 1078, 1079, 1085, 1086, 1087, and 1092, were similar to Stock No. 1075, except for the following characters.

Culms medium to long (86 to 145 cm), thin to medium (0.4 to 0.9 cm); nodes glabrous; leaves medium to wide (1.2 to 2.2 cm); first heading early to medium (mid-May to late May), maturity early to medium (mid-June to late June); panicles medium to long (27 to 47 cm), lemmas dark-brown, dorsal parts hairy [numerous and long (*ca*. 0.5 cm) hairs]; paleas dark-brown.

3. *Avena fatua* subsp. *fatua* var. *intermedia* (LES.) LEJEUNE *et* COURTOIS

Stock No. 1091, collected in Pakistan, was similar to the strains mentioned above, except for the following characters.

Leaves long (47 to 54 cm); first heading late (early June), maturity late (early July); lemmas whitish-gray, dorsal parts hairy [a few and medium-long (*ca*. 0.3 cm) hairs], basal parts hairy [numerous and short (*ca*. 0.1 cm) hairs]; paleas whitish-gray; second lemmas dorsal parts glabrous.

4. *Avena sativa* subsp. *nodipilosa* var. *glabra* (MALZ.)

Stock No. 1088, collected in Afghanistan.

Juvenile growth erect; culms 3 to 4, medium to long (94 to 104 cm), medium-sized (0.6 to 0.8 cm), stiff; nodes green, sparsely hairy; leaves medium-long (31 to 39 cm), medium-wide (1.2 to 1.8 cm), sparsely hairy, liguled; first heading early (mid-May), maturity early (mid-June); panicles medium-long (23 to 39 cm), equilateral, rachis nodes 5 to 7, branches erect; spikelets 2- to rarely 3-flowered, both spikelets and florets separating by fracture of pedicels and the second (and third) floret rachilla segments, respectively (*sativa*-type); empty glumes short to medium (2.1 to 2.6 cm), medium-wide (*ca*. 0.8 cm); first florets short (1.6 to 1.8 cm), slender; lemmas whitish-gray, apical parts 2-toothed, dorsal parts glabrous,

6. *Avena sterilis* subsp. *trichophylla* var. *setigera* MALZEW

Stock Nos. 1083 and 1084.

Juvenile growth erect; culms 3 to 8, long (101 to 133 cm), medium-sized (0.6 to 0.7 cm), stiff; nodes green, densely (Stock No. 1083) or sparsely (Stock No. 1084) hairy; leaves medium to long (27 to 42 cm), medium-wide (1.2 to 1.8 cm), sparsely hairy, liguled; first heading early (mid-May), maturity early (mid-June); panicles medium-long (25 to 31 cm), equilateral, rachis nodes 5 to 7, branches spreading; spikelets 2- to rarely 3-flowered, separating by disarticulation of pedicels (*sterilis*-type); empty glumes short to medium (2.2 to 2.8 cm), medium-wide (*ca.* 0.8 cm); first florets short to medium (1.8 to 2.2 cm), medium-plump; lemmas dark-brown (Stock No. 1083) or whitish-gray (Stock No. 1084), apical parts 2-toothed, dorsal parts hairy [numerous and long (*ca.* 0.5 cm) hairs], awned [medium to long (3.0 to 5.5 cm) and geniculate awns], basal parts hairy [numerous and long (*ca.* 0.5 cm) hairs]; scars medium-long (*ca.* 0.2 cm), round; paleas dark-brown (Stock No. 1083) or whitish-gray (Stock No. 1084), tight; caryopses medium-long (*ca.* 1.0 cm), medium-plump, medium-sized (*ca.* 0.2 cm), hulled; second floret rachilla segments medium-long (*ca.* 0.3cm), hairy [long (*ca.* 0.5 cm) hairs].

7. *Avena sterilis* subsp. *ludoviciana* var. *typica* MALZEW

Stock Nos. 1081, collected in Iran, and 1089, collected in Afghanistan, were similar to stock No. 1083, except for the following characters.

Nodes glabrous; leaves medium to wide (1.4 to 2.3 cm); first heading medium to late (late May to early June), maturity medium to late (late June to early July); panicles medium to long (24 to 42 cm), lemmas dark-brown, paleas dark-brown.

The 60 samples of the *Avena* material studied have been divided into three hexaploid species, *A. fatua*, *sativa* and *sterilis*, each including two or three subspecies. The geographical locations of these plants generally agree with those stated by MALZEW (1930). It is especially noted that neither diploid nor tetraploid species of *Avena* were found in this collection although only a limited number of samples were observed. On the other hand, NAKAO and MORI (1956) gave a description of a tetraploid species (2n=28) under the name of *A. strigosa* SCHREB. subsp. *barbata* (POTT.) THELL. var. *typica* MALZ. subvar. *genuina* (ASCH. et GR.)

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Maize from Afghanistan and Karakoram

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The studies of indigenous maize varieties in the mountainous regions of Asia will afford special interests from the view points of both phylogenetical and ethnobotanical studies of maize. KULESHOV (1928) reported about the Persian type collected in Central Asia and its adjoining Persian–Transcaucasian regions. ANDERSON and BROWN (1953) studied Turkish popcorn and demonstrated that they belong to Aegean and Asiatic groups. SUTO (1956) clearly classified the above two groups, and found that the Asiatic group coincides with the Persian type. ANDERSON *et al*. (1949, 1953) reported the existence of Aegean and Persian types among Assan Hill tribes. SUTO (1956) summarized the distribution patterns of various maize types, in Asia including Caribbean, North American and European types, after his laborious studies of Nepalese maize. However, vast streches between Persia and Nepal were not studied aside. The present study has been carried out for supplementing the above missing link. The original seeds were collected by the members of the Kyoto University Scientific Expedition to the Karakoram and Hindukush in 1955. They were studied in the experiment fields of the University of Osaka Prefecture, Sakai, Osaka, 1956~60.

Material and Method

The original samples of the maize seeds collected in Afghanistan and Karakoram are shown in Table 1. For the purpose of comparison 13 standard strains supplied by Dr. T. SUTO, are also given in Table 2. In 1959, the seeds of all strains were sown on June 6 in a greenhouse and transplanted into the experiment field on June 16. Ten plants of each strain were grown finally. In 1960, they were sown on May 20 and transplanted on May 30. In that year, 15 plants of each strain were finally grown in the field. Necessary observations of the

Table 1. List of samples from Afghanistan and Karakoram

Collection No.	Kernel color	Locality or source	Number of kernels
94	Orange	Purchased in Kabul (alt. 1,800 m), Afghanistan	Many
94–1	Red-orange	〃	2
138	Orange	〃	Many
138–1*	Purple	〃	1
969	Yellow	Pushuki (alt. 2,280 m), Nuristan, Afghanistan	Many
970	White	Kunduz (alt. 400 m), Afghanistan	〃
1086	Orange	Mazar-i-Sharif (alt. 350 m), Afghanistan	〃
1086–1*	Red	〃	1
1120	White	Gilgit (alt. 1,700 m), Karakoram, W-Pakistan	Many
1121	〃	Nomal (alt. 1,900 m), Karakoram, W-Pakistan	〃
1121–1	Red stripe	〃	11
1121–2	Yellow	〃	10
1121–3*	Orange	〃	3
1121–4	Red	〃	2

* Died in 1956.

Table 2. List of types used for comparison

Strain No.	Type*		Original habitat	
1	Persian	(N–7)	Nepal	
2	〃	(N–81)	〃	
3	Caribbean	(J–11)	Kyushu,	Japan
4	〃	(J–12)	Shikoku,	〃
5	〃	(J–9)	Fuji,	〃
6	Aegean	(N–74–2)	Nepal	
7	〃	(N–70)	〃	

generation. For example, strain 94 was divided into 94-A and 94-B. Thus, the total number of strains finally analysed was 15.

2. The studies were concentrated in classifying the materials into already established types, *i.e.* Persian, Aegean, Caribbean, European and North American types. The results are summarized in Appended Table 1.

Based on the careful investigations of a number of criteria, the Afghanistan and Karakoram maize strains were classified into three groups: four strains (138-B, 970-A, 1086-B, 1120-B) into pure Aegean, six strains (94-A, 1086-A, 138-A, 94-B, 969-A, 970-B) into one Aegean type which are introgressed by European type, and five strains (969-B, 1120-A, 1121-A, 1121-1-A, 1121-1-B) into the other Aegean type which are introgressed by Caribbean type.

Geographical distribution

As SUTO (1956) suggested, the long belt of the Asiatic mountains from Malaya to Persia through the Himalaya and the Karakoram Mountains is the home of the Persian type maize. The Aegean type is distributed on the old continent around the area of Persian type. The present materials are broadly coincident with SUTO's result. The pure Persian type was not found in Afghanistan and Karakoram materials. The pure Aegean type was found in the strains from Kabul, Mazar-i-Sharif and Gilgit.

Other Afghanistan strains belonged to the group which was originally the Aegean type but was introgressed by the European type. This introgression must have proceeded from the West. Most of the Karakoram strains were originally Aegean but were introgressed by the Caribbean type which must have been introduced in a later period. The uniformity of the Aegean type on these mountainous region types of Afghanistan and Karakoram is minimizing the change by these introgressions.

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Appended Table 1. Comparison of numerous criteria relating to the five types of maize. The standa
strains are denoted only in terms of abbreviation as Pe, Ae, E, Ca and Na for Persian, Aegean, European, Caribbean and North American respectively

Criteria / Material	Type finally decided	Locality	Earliness	Proterandry[3]	Stalk
Pe (st. 1, 2)			Late	Short	Very hi
Ae (st. 3, 4, 5)			Very early to early	Short to medium	Low to
E (st. 6, 7, 8, 9)			〃	Long	Very lo
Ca (st. 10, 11)			Medium to late	Medium to long	Medium
Na (st. 12, 13)			Early	Long	Low
94 – A	Aegean type I[1]	Kabul, Afghanistan	Very early	Very short	Very lo
1086 – A	〃	Mazar-i-Sharif, 〃	〃	〃	〃
138 – A	〃	Kabul, 〃	〃	〃	〃
94 – B	〃	〃 〃	Early	Short to medium	Low
969 – A	〃	Nuristan, 〃	Very early	Short	Very lo
970 – B	〃	Kunduz, 〃	Early	〃	Low
138 – B	Pure Aegean type	Kabul, 〃	〃	〃	〃
970 – A	〃	Kunduz, 〃	〃	Short to medium	Medium
1086 – B	〃	Mazar-i-Sharif, 〃	〃	Very short	Low to
1120 – B	〃	Gilgit, Karakoram	〃	Short	Medium
969 – B	Aegean type II[2]	Nuristan, Afghan.	〃	〃	〃
1120 – A	〃	Gilgit, Karakoram	Early to median	Variable	Medium
1121 – A	〃	Nomal, 〃	Early	Short to medium	〃
1121-1 – A	〃	〃 〃	〃	Medium	Low
1121-1 – B	〃	〃 〃	〃	Short	〃

1) The Aegean type introgressed by the European type. 2) The Aegean type introgressed by the Caribbean typ
3) 0~2.5 days=very short, 2.5~5.5 days=short, 6~7 days=medium, 8~13 days=long.

Appended Table 1. (Continued)

Prop-roots	Stalk internode[4]	Leaf length[5]	Leaf width[6]	Number of leaves on a stalk[7]	Auricle[8]
Many	Thin	Short to medium	Narrow	Many	−
Medium to many	〃	〃	Variable	Medium	−
None	Medium	Short	Narrow to medium	Few	0 +
Medium	Thick	Long	Wide	Many	+
None	Thin	Medium	Narrow to medium	Few	0 +
〃	〃	Very short	Very narrow	〃	−
〃	〃	〃	〃	〃	− 0
Few	〃	Very short to short	Narrow	〃	− 0
Few to medium	〃	Short	〃	〃	− 0 +
〃	〃	Very short to short	〃	〃	0 +
Few	〃	Very short	〃	Few to medium	−
〃	〃	Short	〃	Medium	−
Medium	Medium	Medium	Narrow to medium	〃	−
Few to medium	〃	Short to medium	〃	〃	− 0
Variable	〃	〃	〃	〃	− 0
Few to medium	〃	Medium	〃	〃	0 +
Medium to many	〃	Medium to long	Medium to wide	〃	− 0 +
〃	〃	Medium	Narrow to medium	〃	− 0 +
〃	Thin	Short	Narrow	Few	− 0
Variable	Medium	Short to medium	Narrow to medium	Few to medium	− 0

4) Less than 1.3 cm=thin, between 1.3~1.7 cm=medium, more than 1.7 cm=thick. 5) Less than 55 cm=ve
55~70 cm=short, 70~90 cm=medium, over 90 cm=long. 6) Less than 4.0 cm=very narrow, 4.0~7.0 cm=na
7.0~8.0 cm=medium, over 8.0 cm=wide. 7) Less than 8=few, 9~12=medium, over 13=many.
8) + =conspicuous, 0 =ordinary, − =absent. 9) Less than 22 cm=short, 22~28 cm=medium, over 28 cm=

Appended Table 1. (Continued)

Peduncle length[10]	Number of branches on a tassel[11]	Form of tassel	Full length of tassel[12]	Inclusion	Shank len
Short	Medium to many	Strongly drooping	Very short to short	Enclosed	Short to m
Short to medium	Variable	Variable	Short to medium	Variable	Variable
Medium to long	Few	Straight	Short	Naked	〃
Medium	Variable	Drooping	Long	Variable	〃
Medium to long	Few	Straight	〃	〃	Medium to
Short	〃	〃	Very short to short	Naked	Variable
Medium	〃	〃	〃	Variable	〃
Short to medium	〃	〃	〃	Naked	〃
Medium	Few to medium	〃	〃	〃	〃
Medium to long	Few	〃	Variable	〃	Medium to
Medium	〃	Variable	Short	〃	Short
〃	Medium	〃	Short to medium	Variable	Long
Short to medium	〃	〃	〃	〃	Short to m
〃	Few to medium	Drooping	〃	〃	Variable
Medium	〃	Variable	〃	〃	Short
Medium to long	Medium	Straight	Medium	〃	Medium to
Medium	〃	Variable	Variable	〃	Variable
〃	Variable	〃	〃	〃	〃
〃	Few	Straight	Short	〃	Short
Long	〃	Drooping	Medium to long	Naked	Variable

10) Less than 16 cm = short, 16～24 cm = medium, over 25 cm = long. 11) Less than 20 = few, 20 = medium, o

12) Less than 40 cm = very short, 40～54 cm = short, 54～58 cm = medium, over 58 cm = long.

13) Less than 5 cm = short, 5～7 cm = medium, more than 7 cm = long.

Appended Table 1. (Continued)

Relative height of ear	Ear width[14]	Ear shape	Cob diameter in cm.	Pith diameter in cm.
Very high	Slender	Conical	2.09	0.63
Variable	Slender or gross	〃	2.21	0.53
Very low or low	Slender	Variable	2.14	0.63
High	Variable	〃	2.95	1.10
Very low	Slender	Cylindrical	2.22	0.50
Very low or low	〃	Conical	1.88	0.53
〃	〃	〃	2.15	0.81
Low	〃	〃	2.17	0.73
〃	〃	〃	2.17	0.72
〃	Variable	〃	2.39	0.79
〃	Slender	〃	2.07	0.77
Medium	Variable	〃	2.38	0.82
Medium to high	Slender	〃	2.16	0.71
Medium	〃	〃	2.21	0.73
〃	〃	〃	1.98	0.58
Low	〃	〃	2.47	0.86
Medium to high	Gross	〃	2.55	1.00
Variable	〃	〃	2.40	0.85
Medium	Slender	〃	2.10	0.74
〃	Medium	〃	2.35	0.65

14) Less than 35 mm in diameter=slender, more than 35 mm in diameter=gross.

Millet from Afghanistan and Karakoram

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Members of the Kyoto University Scientific Expedition to the Karakoram and Hindukush in 1955, collected numerous seed samples of crop plants. Among their collections they found some millet grains. One of them was *Sorghum*, but all the others belonged to proso millet (*Panicum miliaceum*) or Italian millet (*Setaria italica*). These two species of millet were found rather uniformly cultivated in almost everywhere along the expedition route. This fact would indicate that they have been the old staple crops in these territories.

The introduced millets were studied in the experiment field of the University of Osaka Prefecture, Sakai, Japan.

Italian millet (*Setaria italica*)

The original samples of Italian millet are shown in Table 1. The grains from Karakoram (Nos. 1158, 1160 and 1164) were all yellow-colored but the grains from

Table 1. List of KUSE samples of *Setaria italica*

Strain No.	Kernel color	Locality		
606	Yellow	Charikar,		Afghanistan
974	Greyish-yellow	Pushuki,	Nuristan,	〃
974−1	Orange	Pushuki,	〃	〃
975	Yellow	Voma,	〃	〃
975−1	Black	〃	〃	〃
976	Yellow	〃	〃	〃

Afghanistan were yellow-, orange- or black-colored. They were separated and sown in the experiment field.

The Italian millets showed somewhat wide segregation. In one strain, the number of tillers varied from one to twelve or more. The height of the plants also varied. For example, in No. 976, some plants attained 110 cm in height while the others only 55 cm. In some of the strains the wild characteristics, such as stem slanting, many tillers and easy shattering of spikelets, were exhibited. On the whole Italian millets from Karakoram were uniform with the ordinary type, but those from Nuristan were extremely variable and some showed wild characteristics.

Proso millet (*Panicum miliaceum*)

The samples studied are shown in Table 2. They were sown and studied in 1956 and 1957. In most strains, segregation was observed, and those segregants were treated as new derivative strains with the strain numbers of 1159-1-A, 1159-1-B and so on. The results of successive two year studies are summarized in Table 3. The common type of panicles in proso millet seems to be a contracted type, but is not a dominant character. The dominant panicle type is a diffused type which is thought to be most primitive because most of the wild species of the genus *Panicum* have this type. The rounded panicle type is also found only in two strains and they are very close to the contracted type.

A sharp difference was observed between the strains in color of the kernel and stigma, as given in Tables 2 and 3. Proso millet is a hairy plant, namely

Table 2. List of KUSE samples of *Panicum miliaceum*

Strain No.	Kernel color	Locality	
972	Orange	Nuristan,	Afghanistan
972-1	Dark-brown	〃	〃
973	Orange	〃	〃
977	Orange-yellow	〃	〃
1085	Yellowish-orange	Kunduz,	〃

Table 3. Characters of *Panicum miliaceum* of raised plants (* Sown on April 1)

Character / Strain No.	Heading date*	Panicle type	Stigma color	Leaf hair	Strains with the same type
1161	early June	contracted	white	hispid	
1162-A	〃	diffused	purple	〃	1162-D, 1162-C, 1162-B, 972-1-B
1163-C	middle June	contracted	white	densly hispid	
1159-2	〃	diffused	〃	hispid	972-B, 972-A, 1159-1-E, 1159-2-A, 1159-2-C, 1159-B
1159-1-A	〃	〃	light-purple	〃	972-1-A, 972-1-C
1159-1-C	〃	rounded	purple	〃	
1159-1-D	〃	diffused	white	〃	1159-1-F, 1159-2-3, 1159-1-G, 1159-C, 1159-1-H, 1159-1-L, 1159-2-E, 1159-2-2
1162-1	〃	〃	dark-purple	〃	1159-1-B
1163-G	late June	contracted	white	densly hispid	1163-A, 1163-D, 1163-F, 1163-E
977-C	〃	〃	purple	hispid	1163-B, 973-A, 973-B, 973-C, 977-B
1085	〃	rounded	white	densly hispid	
1159-2-D	〃	diffused	〃	hispid	1162-2, 1159-A
1159-D	〃	〃	light-purple	〃	
KP3	early July	contracted	dark-purple	〃	

the leaf-blade, leaf-sheath and stem are all covered by hispid hairs. In the present materials there are no differences in the hairiness of stem and leaf-sheath, but there is little difference in the hairiness grade of leaf-blade as shown in Table 3.

As for the physiological characters, observations were made after a certain days from the sowing to the shooting of panicles. The results are shown in

Table 4. Number of days required from sowing to shooting in *Panicum miliaceum*

Strain No. \ Date sown	1/IV	21/IV	12/V	31/V	21/VI	10/VII	31/VII
1161	65±1.6	56±2.7	48±2.0	41±0.8	36±0.7	33±1.1	30±0.8
1162-A	68±2.5	59±2.2	47±1.1	40±1.1	35±0.8	31±0.9	29±0.5
1163-C	78±2.9	64±2.9	53±2.7	46±0.8	38±1.2	35±0.9	31±1.4
1159-2	75±1.8	63±3.9	52±1.9	45±1.6	38±1.3	36±0.8	34±1.8
1159-1-A	77±3.5	63±1.4	53±1.4	46±0.8	38±0.9	35±0.7	34±1.0
1159-1-C	78±2.5	65±3.3	52±1.8	47±1.2	40±1.1	35±0.5	33±0
1159-1-D	77±1.9	62±3.5	53±2.0	47±1.2	39±1.0	37±1.5	34±1.2
1162-1	72±1.4	63±2.6	51±2.6	44±0.5	38±0.7	33±1.1	34±1.1
1163-G	82±2.7	65±2.5	53±1.3	47±1.8	39±0.7	35±0.8	33±0.7
977-C	80±2.4	68±3.0	63±1.9	50±1.6	43±1.8	36±0.7	34±0.8
1085	81±1.3	65±1.9	55±2.5	47±0.8	39±0.8	36±0.7	32±1.3
1159-2-D	74±2.7	66±5.3	55±1.8	46±1.3	38±0.9	36±1.1	34±0.8
1159-D	75±2.7	63±3.4	53±2.6	46±0.8	38±1.0	35±0.7	33±1.4
KP3	74±1.4	64±3.9	56±2.5	47±1.4	39±1.9	35±0.7	36±0.7

Table 5. The number of leaf blades in the materials with different sowing dates in *Panicvm miliaceum*

Strain No. \ Date sown	1/IV	21/IV	12/V	31/V	21/VI	10/VII	31/VII
1161	11±0.7	11±0.3	10±0.3	11±0.7	10±0.4	10±0	9±0
1162-A	11±0.5	11±0.4	10±0.5	10±0.3	10±0.8	10±0.3	9±0
1163-C	12±1.2	12±0.5	12±0.7	12±0	11±0.3	12±0.5	10±0.4
1159-2	13±1.0	12±0.5	12±0	12±0.7	12±0.3	12±0.5	11±0.6
1159-1-A	12±1.2	13±0.5	13±0	13±0.4	11±0.4	12±0.3	11±0.5
1159-1-C	12±1.3	12±0.5	11±0	12±0.5	11±0.3	10±0.7	10±0.5
1159-1-D	12±1.1	13±0.6	13±0.4	13±0.5	11±0.5	13±0.5	11±0.5

Cytogenetical studies of barnyard grass collected in Afghanistan and Iran

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Seeds of barnyard grass collected in Afghanistan and Iran by the members of the Kyoto University Scientific Expedition (KUSE) to the Karakoram and Hindukush in 1955, were placed at the disposal of the present author for crossing experiments with Japanese, North American and German strains of ***Echinochloa crus-galli***.

This paper deals with cytogenetical studies of barnyard grass from those sources with special reference to their phylogenical relationships.

Material and Method

The strains of barnyard grass collected by KUSE were as follows.

Strain	Locality
224 – BII	Afghanistan
AfK – 1	Kabul–Pul-i-Khumri, Afghanistan
AfK – 3	Mazar-i-Sharif, Afghanistan
IrN – 2	Shahrud, Iran
K974 – 1	Afghanistan

Japanese, North American and German strains used in the artificial crosses were as follows:

Japanese strain, W3, belonging to *Echinochloa crus-galli* var. *praticola* OHWI.

obtained from the 'Institut für Kulturpflanzenforschung, Gatersleben,' Germany. These strains are hexaploid and treated as *E. crus-galli* var. *aristatum* (PURSH.) MANSF. (MANSFELD 1952).

The artificial crosses were made by the same technique as used in *Setaria* by KIHARA *et* KISHIMOTO (1942), and *Echinochloa* by YABUNO (1953).

The spikelets were fixed with 1 : 3 acetic alcohol and the meiosis in PMC's were observed by acetocarmine squash method.

In order to examine pollen-fertility, anthers were collected from just flowering florets several times at intervals of several days and were kept in 70% alcohol. Pollen grains were stained by an iodine-potassium-iodide solution. Well stained pollen grains were classified as good, while those which were empty or reduced in content were classified as bad.

Results

1. Chromosome number

All the KUSE strains from Afghanistan and Iran showed 27 bivalents at the first metaphase in PMC's. They are therefore the hexaploid species with the basic number nine known in the genus *Echinochloa* (YABUNO 1953).

Some characteristics of the KUSE strains:

Based on morphological characters, all the strains could be treated as *E. crus-galli* BEAUV. However, AfK-1 is a new type in regard to the lemma of sterile floret. Some morphological and ecological characters are given in Table 1. They belong to an early group of *E. crus-galli* in regard to the heading date.

Table 1. Some characters of *Echinochloa crus-galli* BEAUV. collected in Afghanistan and Iran by KUSE, 1955

Strain	Heading date* (1959)	Spikelet size (mm)			Awn length (cm)	Stigma color	Lemma of sterile floret
		Length	Thick-ness	Width			
224 – BII	13/VII	3. 7	1. 2	1. 7	0.5 (A few spikelets awned)	Red	Flat
							Stiff and

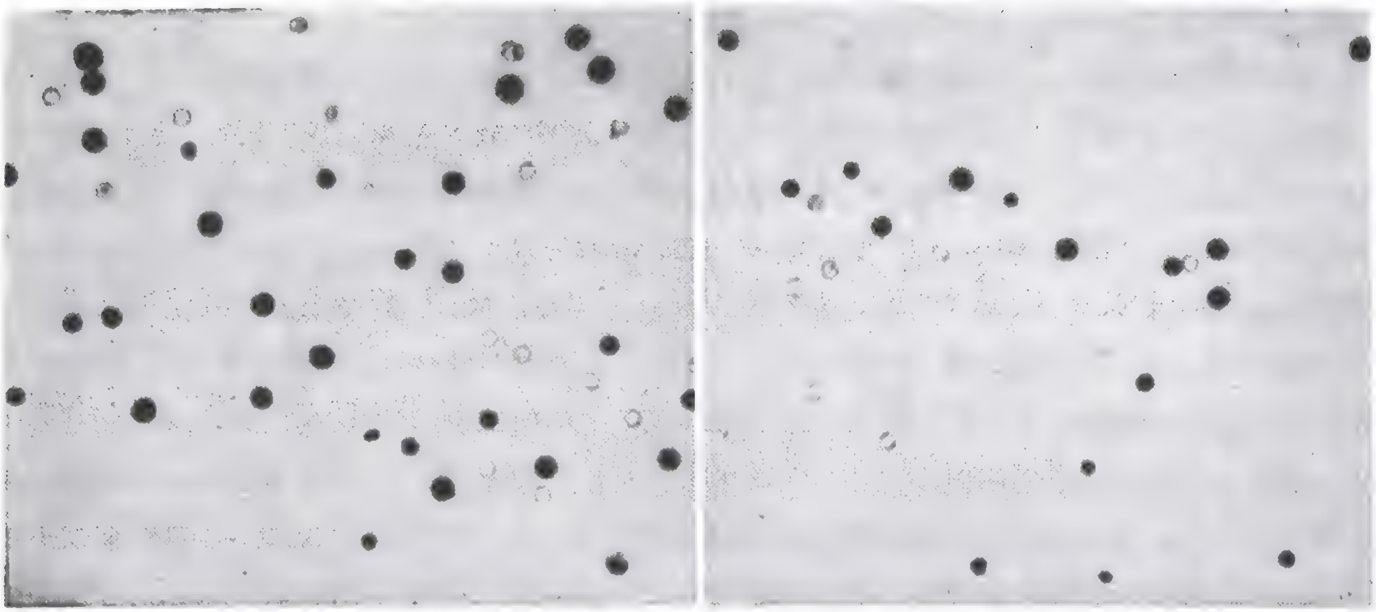
2. Hybrids

Five hybrids among the KUSE strains and also four hybrids of the KUSE strains with the North American strains, two hybrids with the German strains and three hybrids with the Japanese strain were obtained. All the crossings were easy, and the hybrids showed normal growth. In the cross combinations with AfK-1, the convex lemma of the sterile floret and white color, of the stigma of AfK-1 behaved as dominant over flat and as recessive to red color respectively. At the first metaphase in PMC's 27 closely conjugated bivalents were observed. The first and second divisions proceeded quite normally. In spite of the normal meiosis, however, the hybrids were semi-sterile or highly sterile as summarized in Table 2. The sterile pollen grains were smaller than the fertile pollen grains. The size of the fertile pollen grains was irregular (Fig. 1. a, b). Pollen-fertility of the parents was higher than 90%.

The pollen-fertility of the F_1 hybrids among the KUSE strains ranged from 75 to 50%. The same values were obtained in three of the four hybrids between

Table 2. Pollen-fertility in the F_1 hybrids among the KUSE strains and the F_1 hybrids of the KUSE strains and the North American, German and Japanese strains of *E. crus-galli*

Cross combination	Number of pollen grains examined	Number of good pollen grains	% of good pollen grains
AfK-1×IrN-2	5,718	2,984	52.1
AfK-1×224-BII	5,644	3,050	54.0
AfK-1×K974-1	7,138	5,434	76.1
Reciprocal	10,325	7,449	72.1
K974-1×IrN-2	4,167	2,819	67.6
U. S. A.-I×224-BII	11,986	5,206	43.4
AfK-1×U. S. A.-I	19,689	12,003	60.9
AfK-1×U. S. A.-C	5,099	2,840	55.6
IrN-2×U. S. A.-I	1,863	1,150	61.7



a: AfK-1 × U. S. A.-C b: W3 × AfK-1

Fig. 1. Pollen grains of the F_1 hybrids

the KUSE strains and the North American strains and in one of the two hybrids between the KUSE strains and German strains.

However, the hybrids with the Japanese strain showed low pollen-fertility, i. e. 16, 19 or 21% (Table 2). Accordingly, it can be assumed that the KUSE strains are more closely related to the North American and the German strains than to the Japanese strain. Cross sterility appeared to depend on the genotypes of the parents.

3. Segregation in the F_2 of AfK-1 × U. S. A.-C

AfK-1 has convex lemmas of sterile florets while U. S. A.-C has flat ones. As the lemma of the F_1 was convex, the convex lemma can be regarded as dominant. The segregation in the F_2 was 52 convex : 15 flat (3 : 1 ratio, $\chi^2=0.24$, $P=0.7\sim0.5$). Therefore, convex lemma must be a simple monogenic dominant character. Pollen-fertility of the F_1 was 55.6%. In the F_2, fertile and semi-sterile plants were segregated (Table 3). OKA (1953) proposed the hypothesis that a certain gene combination produced in meiosis and carried by the microspores and megaspores seems to determine gamete survival.

A genetical factor, X, for normal development of gametes, would be duplicated,

Table 3. Segregation of fertile and semi-sterile plants

and thus F_1 hybrid $X_1x_2 \times x_1X_2$ would be semi-sterile owing to the degeneration of x_1x_2 gametes. Thus, the segregation 7 fertile: 2 semi-sterile plants could be expected in F_2. Furthermore, OKA proposed to assume the second set of gamete development factors, similar to X_1 and X_2, for the variation of normal pollen percentage among plants in the progeny. Semi-sterility in the F_1 (AfK-1 × U. S. A.-C) and the segregation with regard to fertility in the F_2 seem to be interpreted by the hypothesis of OKA.

Summary

(1) Based on the morphological and cytological analyses all strains of barnyard grass from Afghanistan and Iran collected by the members of the Kyoto University Scientific Expedition (KUSE), 1955, belong to *Echinochloa crus-galli* BEAUV.

(2) F_1 hybrids among the KUSE strains, and F_1 hybrids of the KUSE strains with the North American, German or Japanese strains or *E. crus-galli* showed semi-sterility or high sterility. Based on the analyses of pollen-fertility of the F_1's, it was concluded, therefore, that the KUSE strains are more closely related to the North American and the German strains than to the Japanese strain.

(3) From the segregation of fertile and semi-sterile plants in the F_2 of one hybrid, AfK-1 × U. S. A.-C, it was assumed that pollen-sterility in this hybrid seems to be controlled by some genetical factors.

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Buckwheat from Afghanistan and Iran

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Buckwheat was formerly an important grain crop in the Orient. According to DE CANDOLLE (1884) and VAVILOV (1935), the place of origin is thought to be in north central Asia, including Siberia and China.

Among the strains introduced by the Kyoto University Scientific Expedition (KUSE) to the Karakoram and Hindukush in 1955, three species of *Fagopyrum*, namely *esculentum*, *tataricum* and *cymosum* were included. The former two species were widely cultivated, while the last one was wild.

Material and Method

16 strains of *F. esculentum*, 19 strains of *F. tataricum* and one strain of *F. cymosum* collected by KUSE, and also two summer and two autumn varieties cultivated in Japan were used in the present investigations.

In 1958, the seeds were sown on Sept. 7, but in 1959 the seeds were sown on the first day of every month from April to October, in the experiment field of the Faculty of Agriculture, Miyazaki University, Miyazaki, Japan.

Morphological characters

1. Hetrostyly

F. esculentum and *F. cymosum* exhibited heterostyly as is shown in Fig. 1. The segregation of the long and short style plants was about 1 : 1, having the former long style and short stamen, and the latter having short style and long stamen. It was found that pollination by bees and other insects only

a. Long style flowers b. Short style flowers

Fig. 1. Hetelostyly in *F. esculentum*

Fig 2. Variation in number of edges of seeds (2~6) in a Japanese summer variety

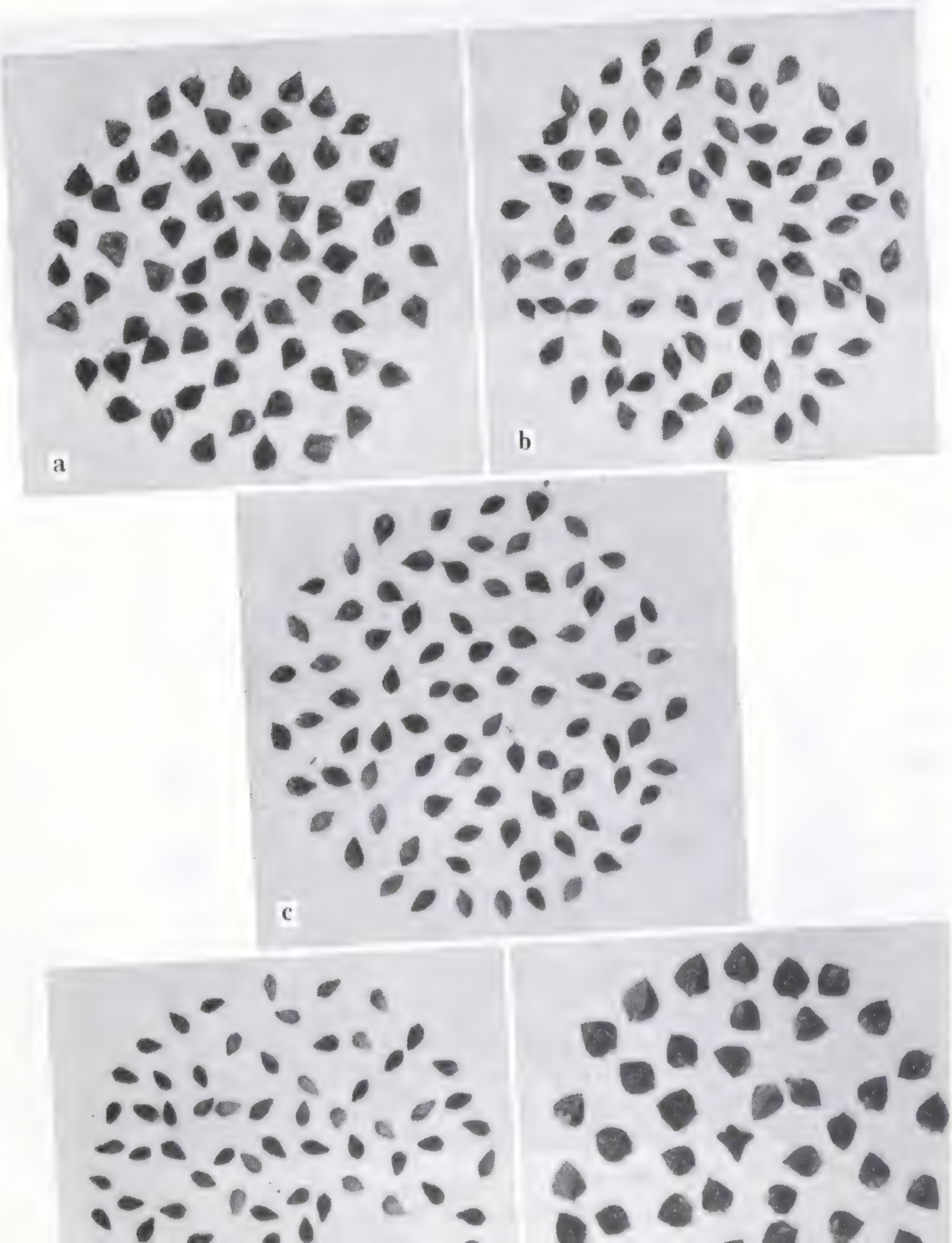

a
b
c

Table 1. Seed and seedling characters in buckwheat

	F. esculentum	*F. tataricum*	*F. cymosum*
Seed:			
length (mm)	6.2 ± 0.38	5.4 ± 0.28	8.6 ± 0.62
breadth (mm)	3.8 ± 0.26	2.7 ± 0.19	7.1 ± 0.51
length/breadth ×100	163	200	121
cotyledon:			
length (mm)	15.5 ± 0.41	14.1 ± 0.69	17.6 ± 0.82
breadth (mm)	26.0 ± 0.96	17.7 ± 0.84	21.8 ± 1.07
breadth/length ×100	168	126	124
hypocotyl length (mm)	140.5 ±15.62	106.5 ± 8.79	11.1 ± 1.46
petiole length (mm)	23.6 ± 2.66	33.1 ± 5.11	76.9 ± 5.79
$\frac{\text{hypocotyl length}}{\text{petiole length}} \times 100$	595	322	14

Fig. 5. Root systems of (a) *F. esculentum* (annual), (b) *F. tataricum* (annual) and (c) *F. cymosum* (perennial)

round. The most conspicuous difference among the three species was found in the length ratio of hypocotyl and petiole of cotyledon (Fig. 4).

4. Root systems

The root systems of three species are shown in Fig. 5. Both *F. esculentum* and *F. tataricum* are the annual but *F. cymosum* is perennial.

5. Other characters

Differences were found among three species in color of cotyledon, color of flower petal, color and hairiness of stem, form of stipule, length of flower stalk and seed setting. *F. tataricum* had more branches and the seed setting was better at a lower node position than *F. esculentum*. In *F. cymosum* the seeds when ripe shattered entirely (Fig. 6).

Table 2. Characteristics of introduced strains of buckwheat, sown in autumn

Material	Germination days*	Days until efflorescence	Node position of first flower	Plant height (cm)
F. esculentum:				
140	A	31.7 ± 2.37	5.3 ± 0.35	74.8 ± 4.26
141	B	32.3 ± 2.42	6.3 ± 0.81	64.6 ± 3.75
150	A	34.1 ± 2.19	6.4 ± 0.94	95.3 ± 6.50
152	A	33.3 ± 2.02	6.4 ± 0.80	80.5 ± 3.79
153	C	39.4 ± 3.39	6.8 ± 0.60	54.4 ± 4.01
154	A	31.5 ± 1.46	5.4 ± 0.55	80.3 ± 3.38
155	B	34.6 ± 1.95	5.4 ± 0.63	55.0 ± 3.23
156	A	33.3 ± 2.75	4.6 ± 0.67	78.8 ± 4.35
157	A	27.7 ± 2.48	2.6 ± 0.40	59.1 ± 3.89
158	A	33.4 ± 1.76	3.7 ± 0.64	85.3 ± 4.93
159	B	38.0 ± 1.87	6.0 ± 0.73	70.8 ± 6.17
160	A	32.1 ± 1.96	5.2 ± 0.54	77.4 ± 4.32
264	A	27.2 ± 2.31	3.4 ± 0.53	70.4 ± 4.63
266	A	28.6 ± 2.44	3.6 ± 0.49	58.7 ± 2.33
269	B	29.7 ± 2.98	4.7 ± 0.61	62.3 ± 2.87
F. tataricum:				
138	C	47.0 ± 2.13	7.7 ± 0.94	48.0 ± 3.20
139	C	48.7 ± 2.33	9.2 ± 1.15	45.5 ± 3.75
142	B	49.9 ± 2.09	9.5 ± 1.29	63.6 ± 4.95
143	C	49.1 ± 2.36	8.3 ± 0.72	54.5 ± 4.08
144	B	43.2 ± 2.77	7.1 ± 0.83	42.1 ± 3.37
145	C	33.0 ± 2.56	6.1 ± 0.84	18.6 ± 2.26
146	B	31.5 ± 2.12	7.3 ± 0.89	25.3 ± 2.95
148	B	31.8 ± 2.56	6.7 ± 0.93	19.1 ± 1.79
149	B	51.3 ± 3.25	9.9 ± 0.77	51.5 ± 3.42
265	A	37.7 ± 2.56	6.6 ± 0.61	59.7 ± 2.57
267	A	38.3 ± 2.15	6.7 ± 0.71	63.3 ± 3.05
268	B	38.2 ± 2.12	7.2 ± 0.96	51.4 ± 2.06
270	B	39.2 ± 1.67	7.3 ± 0.76	50.3 ± 3.66
271	A	37.3 ± 1.78	7.2 ± 0.74	57.6 ± 3.70
272	C	38.0 ± 2.01	8.0 ± 0.85	46.1 ± 2.51

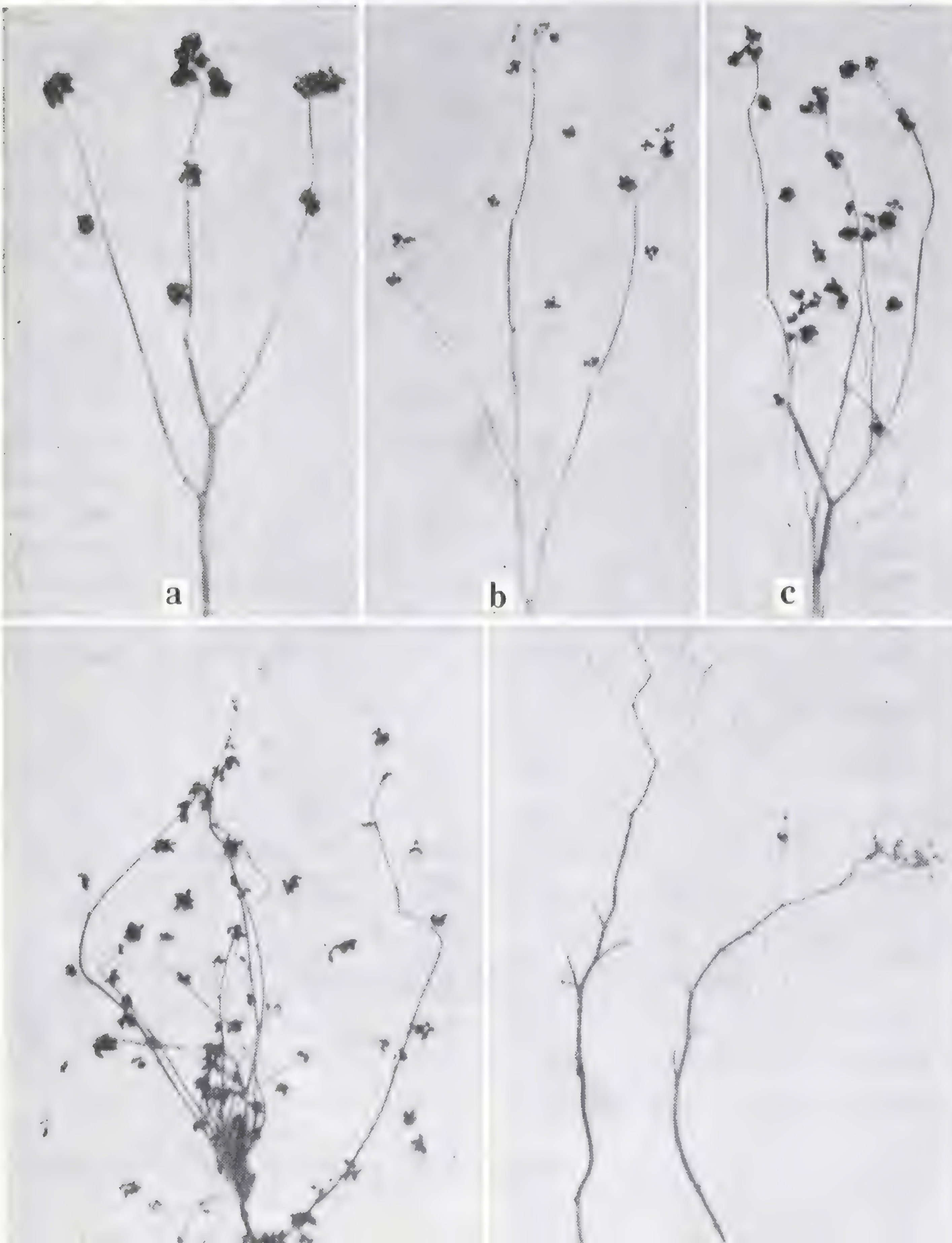

a
b
c

Table 3. Change of days until efflorescence due to the change of sowing time

Sowing time	*F. esculentum*			*F. tataricum*	*F. cymosum*
	Japanese summer variety	Japanese autumn variety	KUSE No. 1116	KUSE No. 1151	KUSE No. 161
April	37.3	42.5	35.8	41.0	85.2
May	36.0	42.4	34.2	41.1	80.4
June	34.3	45.8	33.8	42.6	100.6
July	42.3	67.8	39.5	45.3	70.1
Aug.	29.1	42.4	31.5	36.6	50.8
Sept.	23.6	29.7	27.2	32.3	50.2
Oct.	33.3	33.5	34.1	43.1	—*

* Not flowered.

Table 4. Change of node position of the first flower due to the change of sowing time

Sowing time	*F. esculentum*			*F. tataricum*	*F. cymosum*
	Japanese summer variety	Japanese autumn variety	KUSE No. 1116	KUSE No. 1151	KUSE No. 161
April	3.7	4.3	3.8	7.7	18.8
May	3.8	4.6	3.8	7.1	19.0
June	5.0	7.2	4.6	7.8	36.3
July	5.3	8.9	5.0	7.4	26.0
Aug.	4.8	6.3	4.3	7.3	24.9
Sept.	4.1	4.7	3.7	7.4	18.9
Oct.	3.3	3.2	3.5	5.8	—*

* Not flowered.

Table 5. Change of plant height* due to the change of sowing time

Sowing time	*F. esculentum*			*F. tataricum*	*F. cymosum*
	Japanese summer variety	Japanese autumn variety	KUSE No. 1116	KUSE No. 1151	KUSE No. 161
April	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

2. Date of efflorescense

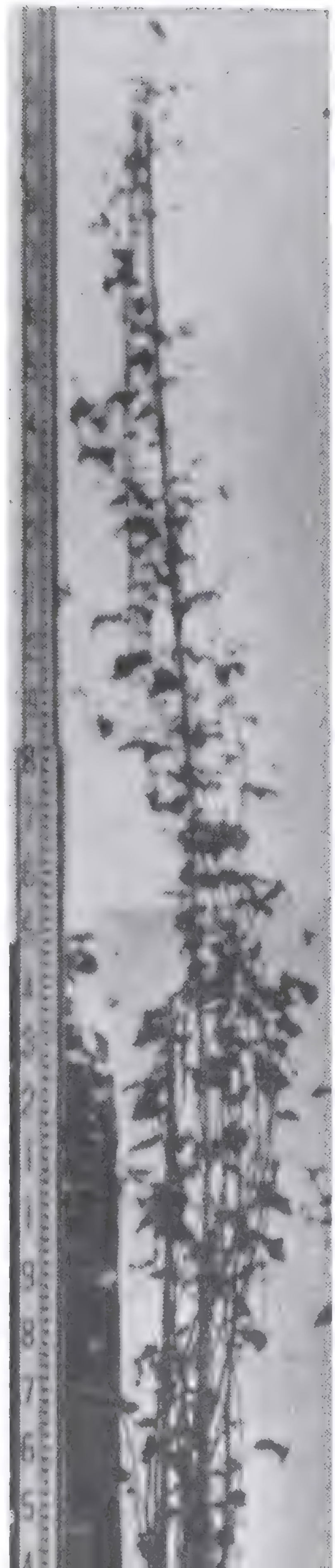
The data of the date of efflorescense are given in Tables 2 and 3. Generally *F. esculentum* and *F. tataricum* flowered earlier than *F. cymosum*. The date of efflorescense was delayed especially when sown in June~July.

3. Node position of the first flower

The data regarding the node position of the first flower are given in Tables 2 and 4. The node position was low in *F. esculentum* and medium in *F. tataricum* and high in *F. cymosum*.

4. Plant height

The data concerning the plant height is given in Tables 2 and 5. When sown in September, *F. tataricum* was short, *F. cymosum* was medium and *F. esculentum* was tall. The plant height was largely affected by the sowing time in the Japanese autumn varieties. In some cases a plant grew surprisingly tall on a prop (Fig. 7). This is because the buckwheat responses to the day length extremely sensitively even after the efflorescence as pointed out by SKOK and SCULLY (1955).



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Watermelons collected in Afghanistan and Iran

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Watermelons are native to South Africa (LIVINGSTONE 1857) and have spread to North Africa, Egypt, South-West Asia, and even farther to Central Asia along the south-western slopes of the Himalayan Range (STUHLMAN 1906, VAVILOV 1931). Being an important crop which supplies delicious fruits, watermelons are now extensively grown in different parts of the world.

In 1955, the members of the Kyoto University Scientific Expedition (KUSE) to the Karakoram and Hindukush collected seeds of watermelons in Afghanistan and Iran. The seeds were sent to the Kihara Institute for Biological Research, Yokohama, and the characteristics of the plants were examined by the present author. Some of the collected strains were crossed with Japanese tetraploid varieties and the triploid hybrids were obtained. This paper describes the characteristics of those diploids and triploids

Material and Method

Along the route of KUSE, 25 strains of watermelons were collected. They

Table 1. List of the collections from Afghanistan and Iran

Strain No.	Locality		Strain No.	Locality	
503	Jalalabad,	Afghanistan	149	Kabul,	Afghanistan
504	Isfahan,	Iran	418	〃	〃
510	Bostonabad,	〃	419	〃	〃
515	Rezaiyeh,	〃	114	〃	〃
516	〃	〃	991	Karachi,	Pakistan
704	〃	〃	992	〃	〃

are listed in Table 1.

The seeds were sown in the hotbed on April 10, 1956. Two strains, *viz.*, Nos. 504 and 724 did not germinated at all. The seedlings were transplanted to the field on May 10. Observations and measurements of the characteristics were made, and the results were compared with those of the Japanese cultivated variety, Asahi-Yamato.

Table 2. Flower and vine characters of watermelons collected in Afghanistan and Iran

Strain No.	Date of flowering		Flowering period in days		Node No. of 1st female flower	Flower type	Length of main vine (cm)	Nodes on main vine	Length of inter-node (cm)	Disease resistance[1)]
	♂	♀	♂	♀						
503	20/VI	30/VI	75	79	27	♂♀	108.5	13	8	S
510	14/VI	23/VI	58	68	24	♂♀	189.8	16	11	S
515	21/VI	29/VI	58	65	28	♂♀	134.5	13	10	S
516	20/VI	30/VI	66	71	28	♂♀	193.8	16	12	S
704	15/VI	23/VI	62	73	22	♂♀	169.8	15	11	R
709	20/VI	30/VI	60	63	20	♂♀	210.2	17	12	S
717	20/VI	24/VI	66	71	29	♂♀	172.4	16	12	S
712	23/VI	22/VI	68	75	19	♂♀	195.5	16	12	S
739	18/VI	23/VI	73	79	22	♂♀	170.4	16	11	S
763	17/VI	27/VI	65	72	28	♂♀	187.5	16	12	S
769	20/VI	24/VI	70	79	26	♂♀	200.5	17	12	S
149	23/VI	30/VII	68	75	28	♂♀	190.5	16	12	S
418	14/VI	25/VI	59	67	26	♂♀	192.4	17	11	S
419	21/VI	28/VI	68	72	26	♂♀	172.6	16	11	S
114	23/VI	30/VI	59	68	28	♂♀	190.5	16	12	S
991	20/VI	25/VI	65	75	25	♂♀	190.8	16	12	S
992	21/VI	25/VI	63	72	28	♂♀	180.6	16	11	S
993	15/VI	22/VI	66	75	27	♂♀	190.7	16	12	S
994	24/VI	29/VI	68	75	25	♂♀	180.5	16	11	S
995	20/VI	28/VI	63	71	28	♂♀	189.4	15	13	S

Results

1. Characteristics of main vine, leaf and flower

Length of the main vine was measured, and nodes on the main vine were counted on June 11, 1956. Date of flowering, flowering period, position of the first female flower, flower type, and disease resistance were examined. The results are shown in Table 2.

In general, the plants showed vigorous growth until the rainy season. Afghanistan and Iran lie between the latitudes 29°N and 40°N, and have a continental climate with little rainfall in summer. Japan's rainy season is in June, and during this season diseases spread very rapidly. Most of the collected strains were severely damaged. Some of the plants in each of the collected strains were attacked by both anthracnose and stem rot, and died. The survivals, however, recovered vigorous growth after the rainy season was over.

Leaves were orbicular to triangular-ovate in shape and always deeply 3∼5 lobed with lobulate to pinnate lobes. Tendrils were elongated and two lobed.

The length of the main vine of all the collected strains except for No. 503

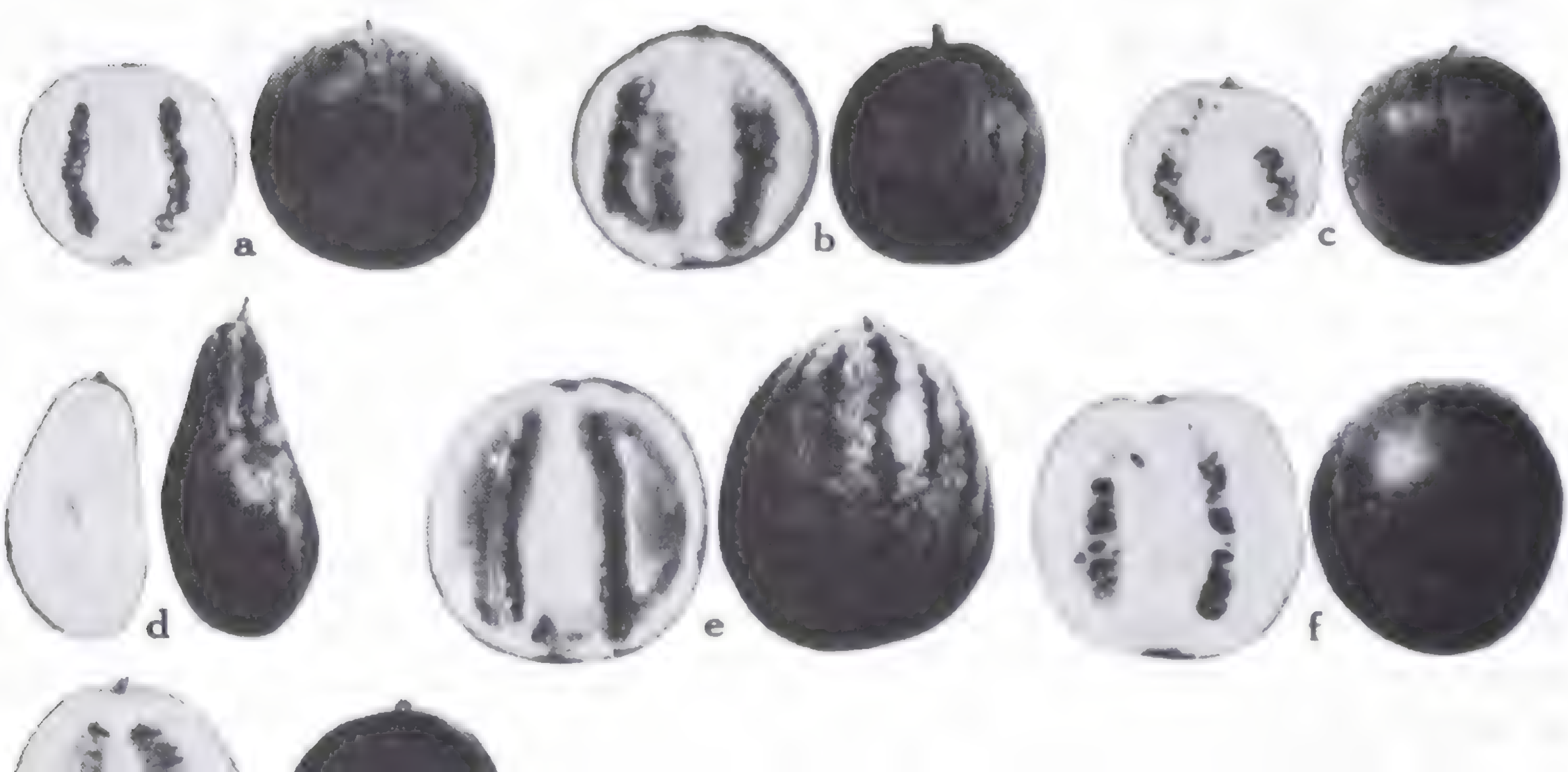

Table 3. Fruit characters of watermelons collected in Afghanistan and Iran

Strain No.	Shape[1)]	Size (cm)	Color of pericarp[2)]	Pericarp pattern[3)]	Color of flesh[4)]	Sweet-ness	Weight (kg)	Thickness of rind (cm)
503	R	19×19	G	S	P	−	2.86	0.8
510	R	13×13	G	S	Y	−	1.42	1.2
515	R	15×15	B	C	P	−	2.01	1.0
516	R	13×13	G	C	Y	−	1.40	1.2
704	OB	25×18	B	C	P	+	3.21	2.0
709	R	13×13	G	C	P	−	1.41	1.0
717	R	8×8	G	S	P	−	0.52	1.0
712	OV	20×15	G	S	P	−	2.63	1.0
739	R	12×12	G	C	P	−	1.25	0.8
763	R	15×15	DG	C	P	−	2.10	1.0
769	R	15×15	DG	S	P	−	2.03	0.9
149	OV	12×9	G	C	P	−	1.01	1.5
418	R	13×13	DG	C	P	−	1.40	1.2
419	OV	20×12	G	C	P	−	2.03	1.5
114	OV	18×14	G	C	P	−	2.27	1.3
991	R	12×12	B	C	P	+	1.26	1.0
992	R	14×14	B	C	P	+	1.65	1.1
993	OV	14×13	G	C	W	−	1.52	1.3
994	R	10×10	G	S	P	−	0.95	1.3
995	OV	17×11	G	C	P	−	1.42	1.2
996	OV	14×12	G	C	W	−	1.47	0.7
997	R	17×17	B	C	P	−	2.52	1.8
1152	R	12×12	G	C	P	−	1.20	1.0

1) R: Round, OB: Oblong, OV: Oval, 2) G: Green, B: Black, DG: Dark-green,
3) S: Striped, C: Whole-colored, 4) P: Pink, Y: Yellow, W: White.

was more than twice as long as that of Asahi-Yamato, but the number of nodes on the main vine was almost equal to that of Asahi-Yamato. The length of internodes of the collected strains, therefore, was more than twice as long as that of Asahi-Yamato.

smaller than the fruits of Asahi-Yamato. Pericarp was black, dark-green or green in color and either striped or whole-colored in pattern. The flesh was pink, yellow or white and slightly solid in texture. With a few exceptions the fruits of the collected strains had a non-sweet flavor.

3. Characteristics of triploids

In 1956, Japanese tetraploid varieties were pollinated with pollen grains of the collected strains, and triploid seeds were obtained. They were sown in 1957. The triploid seeds germinated well and the triploid plants grew normally. They bore seedless fruits.

Of 20 triploid combinations obtained, four were comparatively excellent in fruit characteristics. They are shown in Table 4 and Fig. 2.

Table 4. Characteristics of 3x-watermelons
(Japanese 4x-varieties × KUSE 2x-strains)

Combination		Shape of fruit[1]	Color of pericarp[2]	Pericarp pattern[3]	Color of flesh[4]	Sugar content[5]	Disease resistance[6]
Yamato (4x)	×704	R	DG	S	P	10.8	R
Asahi-Yamato (4x)	×763	R	G	C	P	9.8	R
Fumin (4x)	×739	R	G	S	P	11.6	R
Shin-Yamato (4x)	×712	R	G	S	P	12.0	R

1) R: Round, 2) G: Green, DG: Dark-green, 3) S: Striped, C: Whole-colored,
4) P: Pink, 5) Brix (%), 6) R: Resistant.

The triploids showed vigorous growth and were resistant to disease, in spite of the susceptibility to disease of the collected strains. Fruit shape of the hybrid, round × oblong (or oval), was round. Pericarp color was intermediate between the parents. As to flesh color, red × pink was pink. Flesh of the Afghan and Iranian watermelons were either non-sweet or slightly sweet, but the hybrid fruits were as sweet as those of the tetraploid mother parents.

Consideration

Watermelon (*Citrullus vulgaris* SCHRAD.) originated in South Africa is widely distributed in Egypt, and South-West and Central Asia. Following after the classification of four species, *viz.*, *C. vulgaris*, *C. colocynthis*, *C. ecirrhosus*, and *C. naudinianus*, in the genus *Citrullus* by COGNIAUX and HARMS (1924), many botanists who engaged in the taxonomy of the Cucurbitaceae have published the opinions that two groups of *C. vulgaris*, *viz.*, edible watermelons and bitter or non-bitter wild races, should be treated as two independent species, *viz.*, *C. edulis* PANG. and *C. colocynthoides* PANG. (PANGALO 1930, 1938; GOLDHAUSEN 1938), or two subspecies, *viz.*, *edulis* and *colocynthoides* (REHM *et al.* 1957; SHIMOTSUMA 1963). The former was regarded as cultivated form and the latter as its wild form. They are practically identical to each other in the vegetative characteristics, but differ from each other in fruit characteristics, namely the cultivated form has either red or yellow flesh with sweet flavor, while the wild form always has white flesh with either bitter or non-bitter flavor. Nos. 993 and 996 may be wild watermelons and the other strains the cultivated ones.

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Pumpkins from Afghanistan and Iran

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The seeds of pumpkins were brought to Japan by the Kyoto University Scientific Expedition (KUSE) to the Karakoram and Hindukush in 1955 (Fig. 1). It was thought that the three known species of *Cucurbita* were all native to the American continent (TAKASHIMA 1956). However, it has been thought that India could be the place of origin because a botanist in the 16th century called the original species of *C. maxima* as Indian gourd and named it *Pepo maximus indicus*.

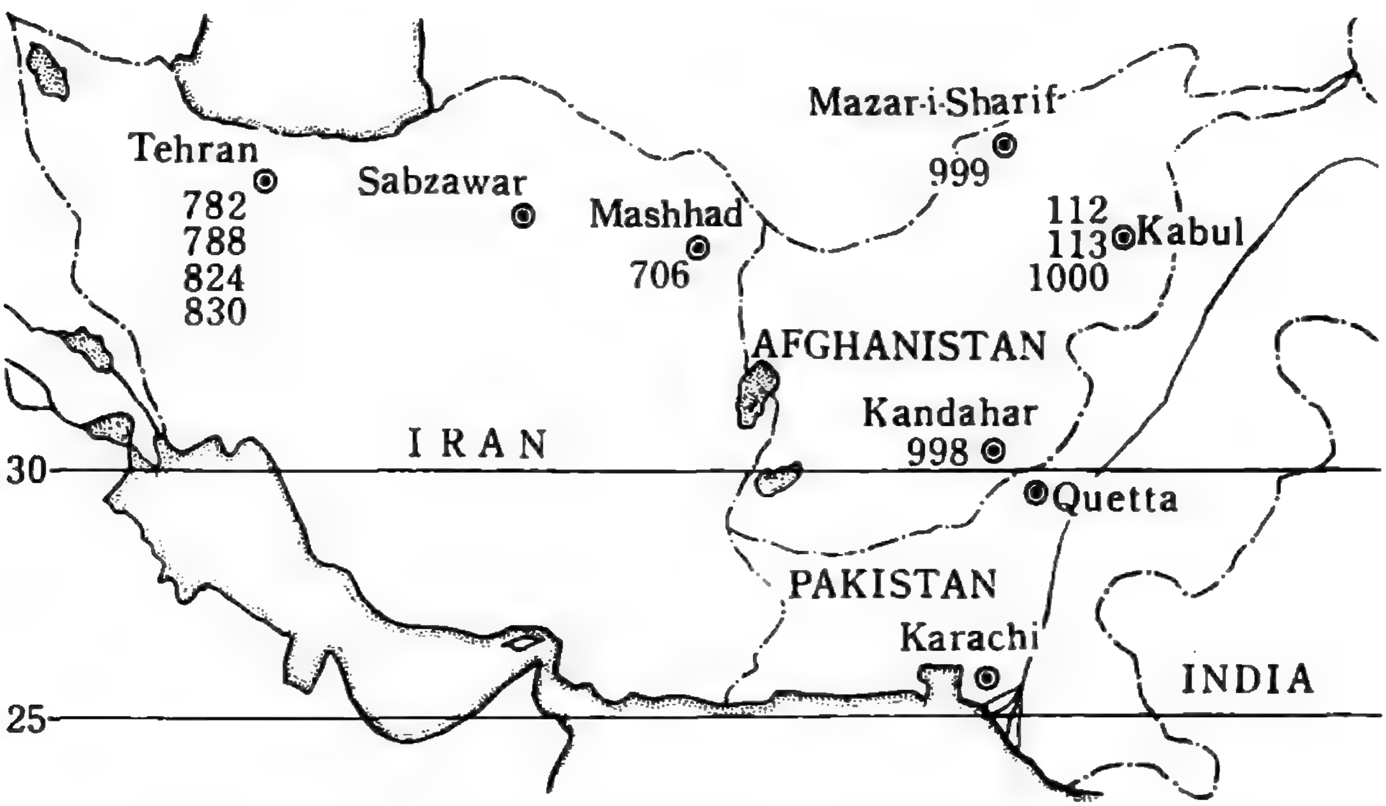


Fig. 1. A map showing the localities of respective KUSE strains

Sir Joseph HOOKER held the opinion of American origin. BARTER emphasized

American botanist because a Brazilian variety "Jurume" illustrated in a figure by PISO is *C. maxima*. BUKASOV (1930) reported, that pumpkins were cultivated only in Southern Peru, Bolivia and Northern Chile in South America. After CATER (1945), the seeds found in an old jar in Peru were thought to be related to those of the present *C. maxima*. He reported that he found the seeds of apparently *C. maxima* in the tomb of Naudin and Ancon (Ancon: a ruin of the ancient Incan Empire). For *C. Pepo* the American Continent was assumed to be its home.

COGNIAUX reported that he collected the seeds of *C. moschata* from Bangha Island in the southeast of Sumatra-Island, while MIQUEL stated that the species was not cultivated there.

There are no other assumptions concerning the origin of this species, but the Oriental origin theory could not be neglected because it is very extensively cultivated in Southern Asia.

The present paper deals chiefly with (1) the systematics of those materials introduced by KUSE, with special reference to the origin of cultivated pumpkins, and also (2) the studies whether any of their characteristics are useful for the breeding purposes in Japan. The investigations were carried out for three years, 1956~1958.

Material and Method

The seeds were sown directly in the Experiment Farm of the Laboratory of Olericulture, Kyoto Pref. Univ., Kyoto, Japan. For the convenience of observations, only one branch vine was left on the main vine and others were trimmed off. For comparison plots of non-trimming were also prepared. The morphological observations were made on the 15th/2nd[1] leaves and on the 3rd/5th female flowers of the main vine. The 2nd/3rd fruits on the main vine of ten plants were used for examinations 40~45 days after flowering. Node positions of the first female flower were observed in relation to the earliness. The heat tolerance and disease resisitance were studied. For this reason no fungicides were applied during cultivation. The materials in our maintainance, wild and cultivated, were used for comparison. Collection Nos. of KUSE have been used as the material Nos. of the present studies.

Table 1. Seed characters

Material No.	Scar	Color	Size (mm)*			Margin color	Weight of 100 grains (gr)
			L	W	L × W		
112	horizontal or round	grayish-white	17.17	9.26	159.0	grayish-white	144.5
706	〃	〃	16.87	8.84	149.1	〃	173.5
782	〃	〃	15.34	8.58	131.6	〃	120.0
824	〃	〃	16.72	9.25	154.7	〃	161.0
1000	round	〃	15.32	8.41	128.8	pale-brown	130.5
788	wavy	〃	15.56	9.05	140.8	〃	141.5
830	〃	〃	15.85	8.83	140.0	〃	125.0
998	〃	deeper grayish-white	16.69	9.05	150.4	〃	143.5
999	〃	〃	16.22	10.22	165.8	〃	185.5
113	slanting	whitish-yellow	18.91	10.12	191.4	white	219.3

* L: length, and W: width, in average.

showed wavy scar as *C. moschata*. The scars of Nos. 112, 706, 782 and 824 were horizontal or round, having the distinct characteristic of *C. Pepo*. No. 1000 was round or intermediate between *C. moschata* and *C. Pepo*.

C. Andreana, *C. ficifolia*, *C. foetidissima* and *C. texana* are considered to be the ancestral species of cultivated pumpkins, but none of the collected materials was classified as any of these species (Fig. 3).

2. Vines and leaves

No. 112 (Fig. 4a): annual, vine-type, growth slightly bad; leaves petiolated, alternate and dark-green without white spots, distinctly indentated, rather deeply incised, incompletly lobed 2~5.

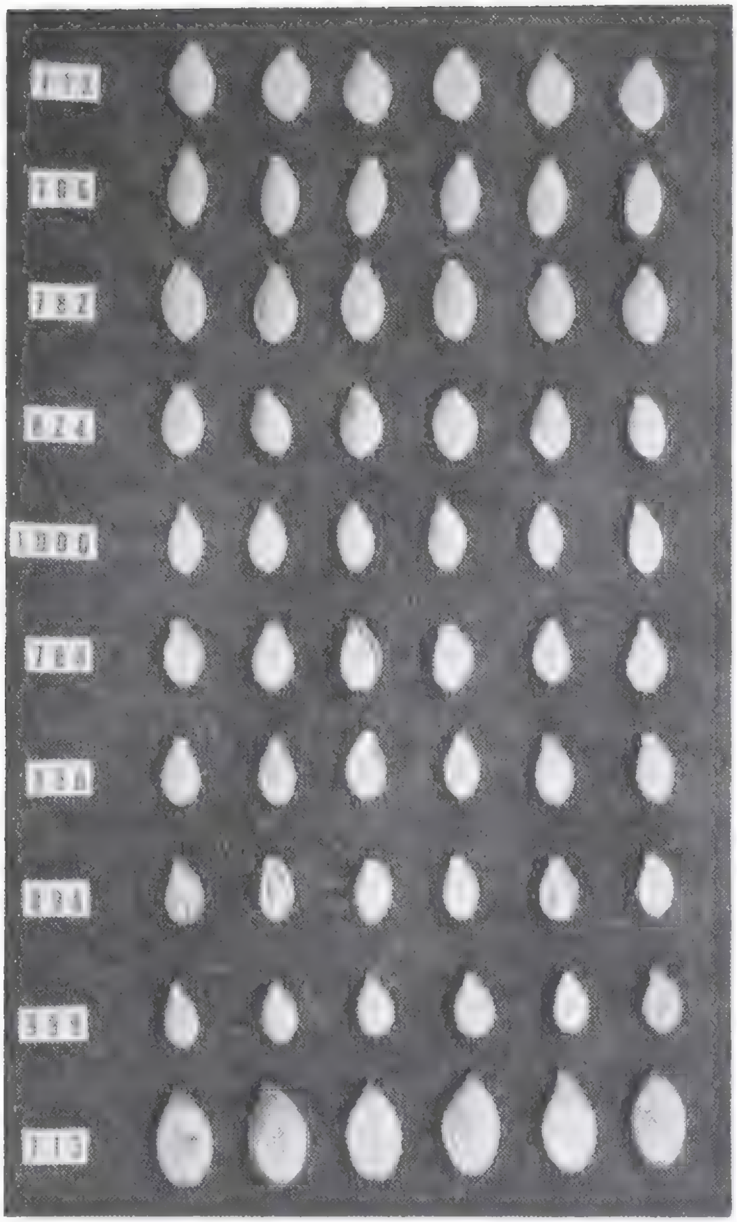
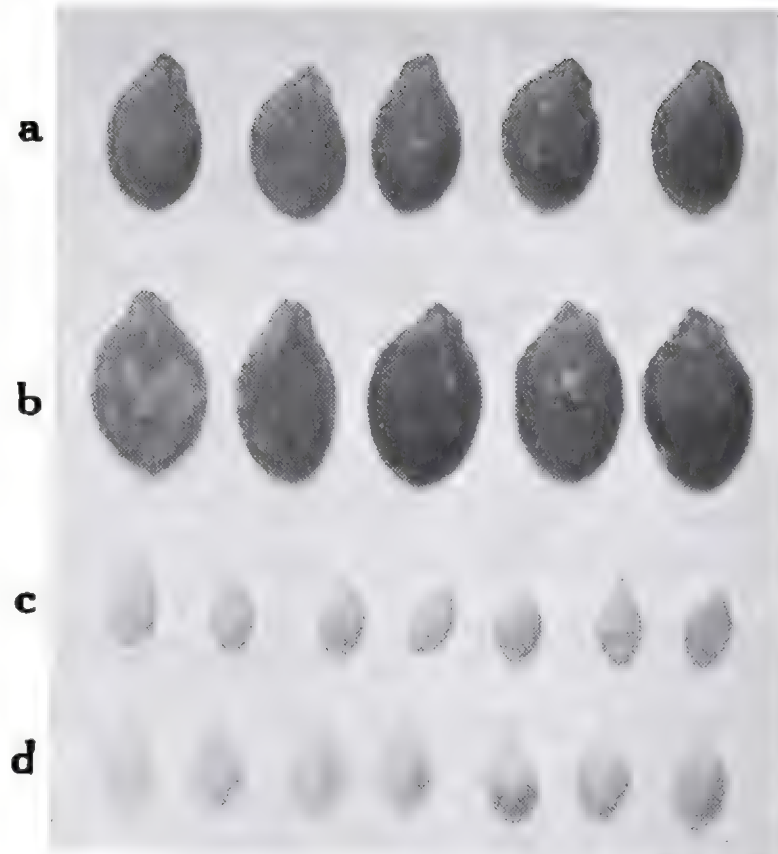


Fig. 2. Original seeds of respective KUSE strains

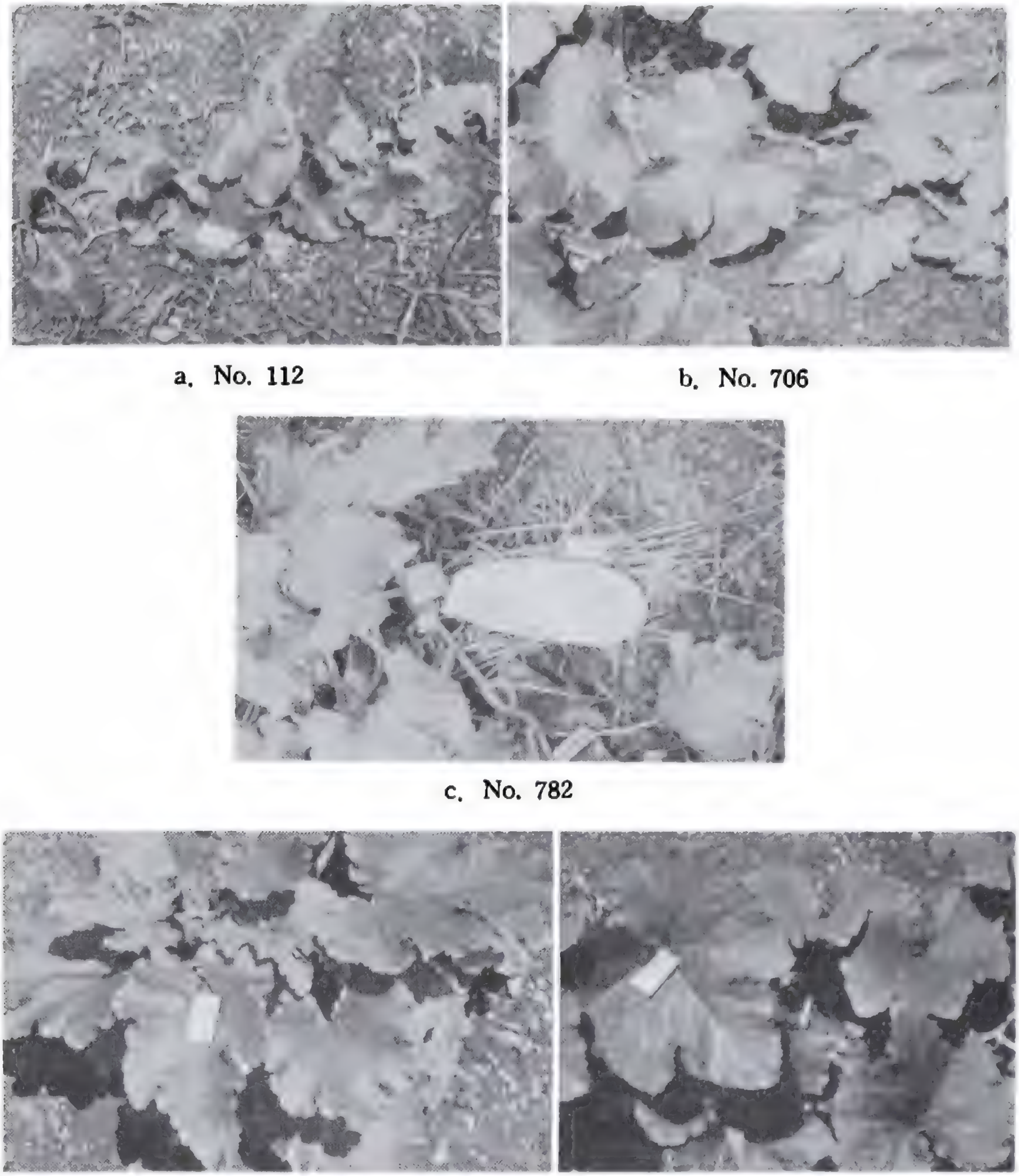


a. *C. ficifolia*
b. *C. radicans*
c. *C. Andreana*
d. *C. texana*

Fig. 3. Seed samples of respective species

Table 2. Leaf characters

Material No.	Leaf-blade				Petiole		Tendril length (mm)
	Size (mm)	Lobes	Color	White Spot*	Length (mm)	Diameter (mm)	
112	113×119	3〜5	dark-green	−	98	4.0	52
706	295×250	5	green	+	241	13.0	152
782	153×153	5	〃	+, −	157	6.3	57
824	213×153	5	〃	+, −	217	9.5	27



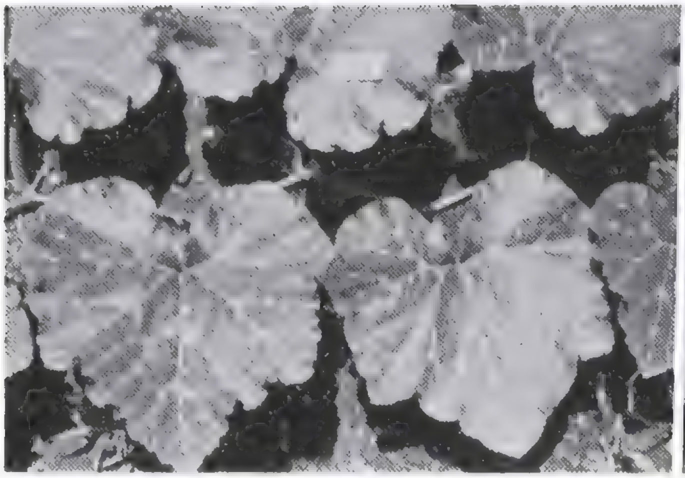
a. No. 112 b. No. 706

c. No. 782

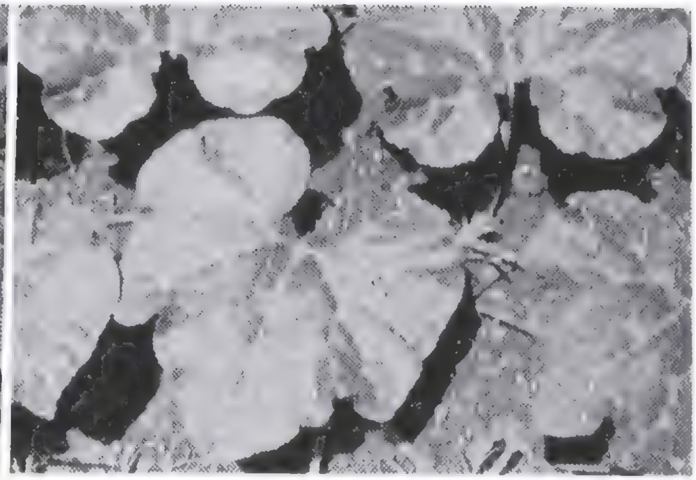
d. No. 824 e. No. 1000

Fig. 4. Growing habits of respective KUSE strains in Kyoto, Japan

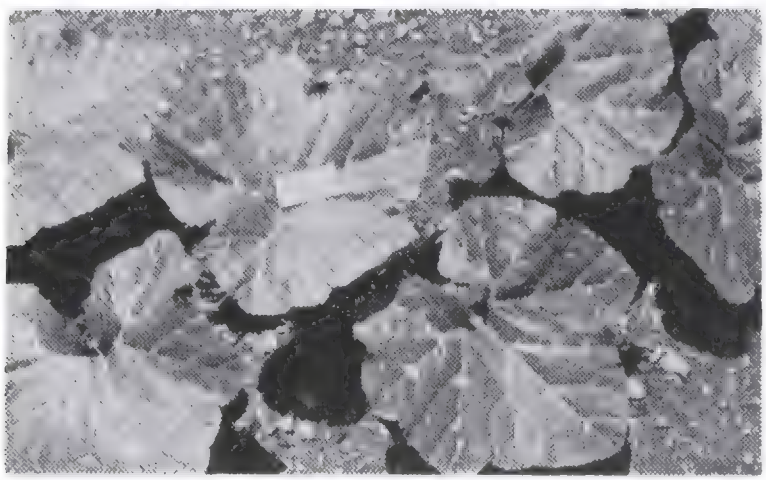
No. 788 (Fig. 5a, Fig. 6c, d): annual, vine-type, growth vigorous; leaves dark-green with many white spots, distinctly indentated, slightly incised, incompletely



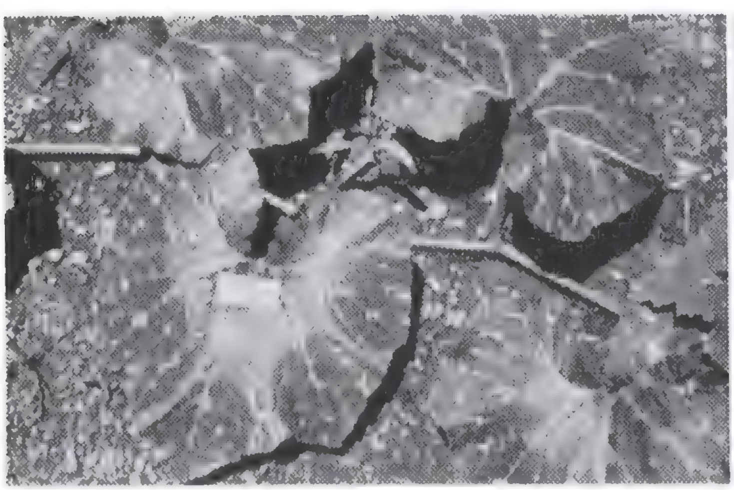
a. No. 788



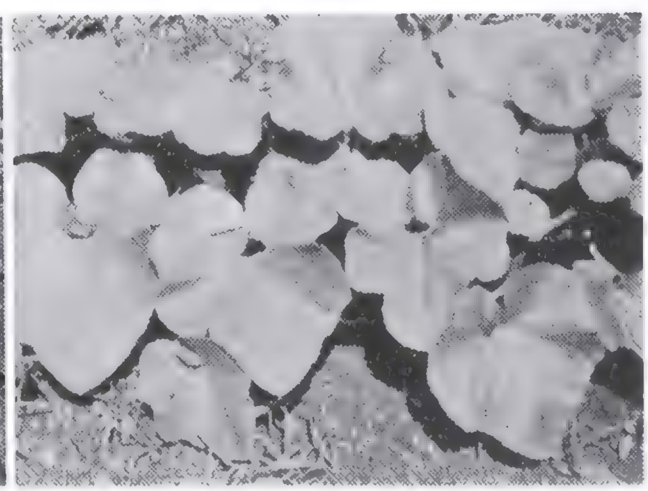
b. No. 830



c. No. 998



d. No. 999

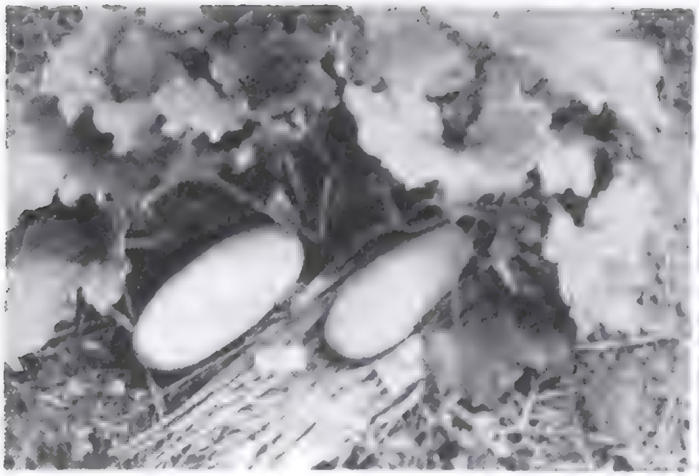


e. No. 113

Fig. 5. Growing habits of respective KUSE strains in Kyoto, Japan

lobed 5; many hairs on leaf and petiole.

No. 113 (Fig. 5e); annual, vine-type; leaves dark-green, without white spots,

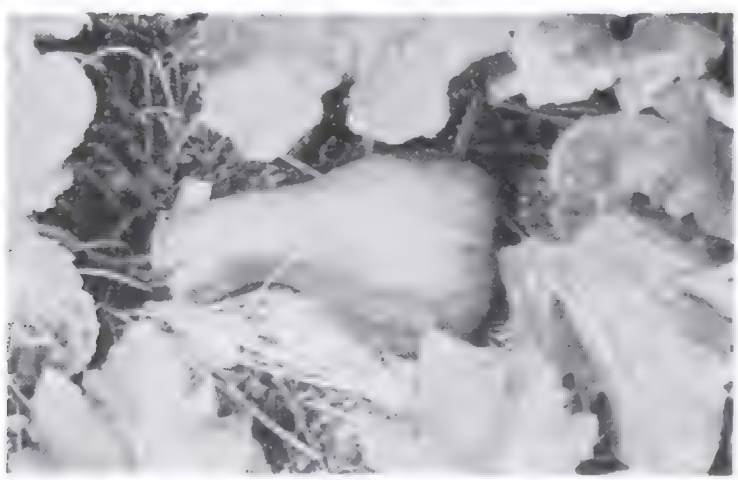


a. No. 824

b. No. 1000

c. No. 788

d. No. 788



e. No. 830

Fig. 6. Growing habits of respective KUSE strains in Kyoto, Japan

spots do not occur. Since No. 113 has thin and stiff hairs on the leaves it will be recongnized as *C. maxima*, though the leaf is incompletely lobed 5. The leaf of

pentagon-shape cross-section peduncle, and yellow-orange corolla color. A few buds of No. 788 are seen in Fig. 6c. Those characteristics mentioned above are those of *C. moschata*. Occasionally *C. moschata* shows the transformation of calyces into leaves. The same was seen in Nos. 998 and 999. Accordingly Nos. 788, 830, 998 and 999 were identified as *C. moschata*. A bisexual flower occurs often in No. 788. Male flowers of No. 113 (Fig. 7j) had needle-shape calyces, round cross-section peduncle, and light-yellow corolla color, being the character-

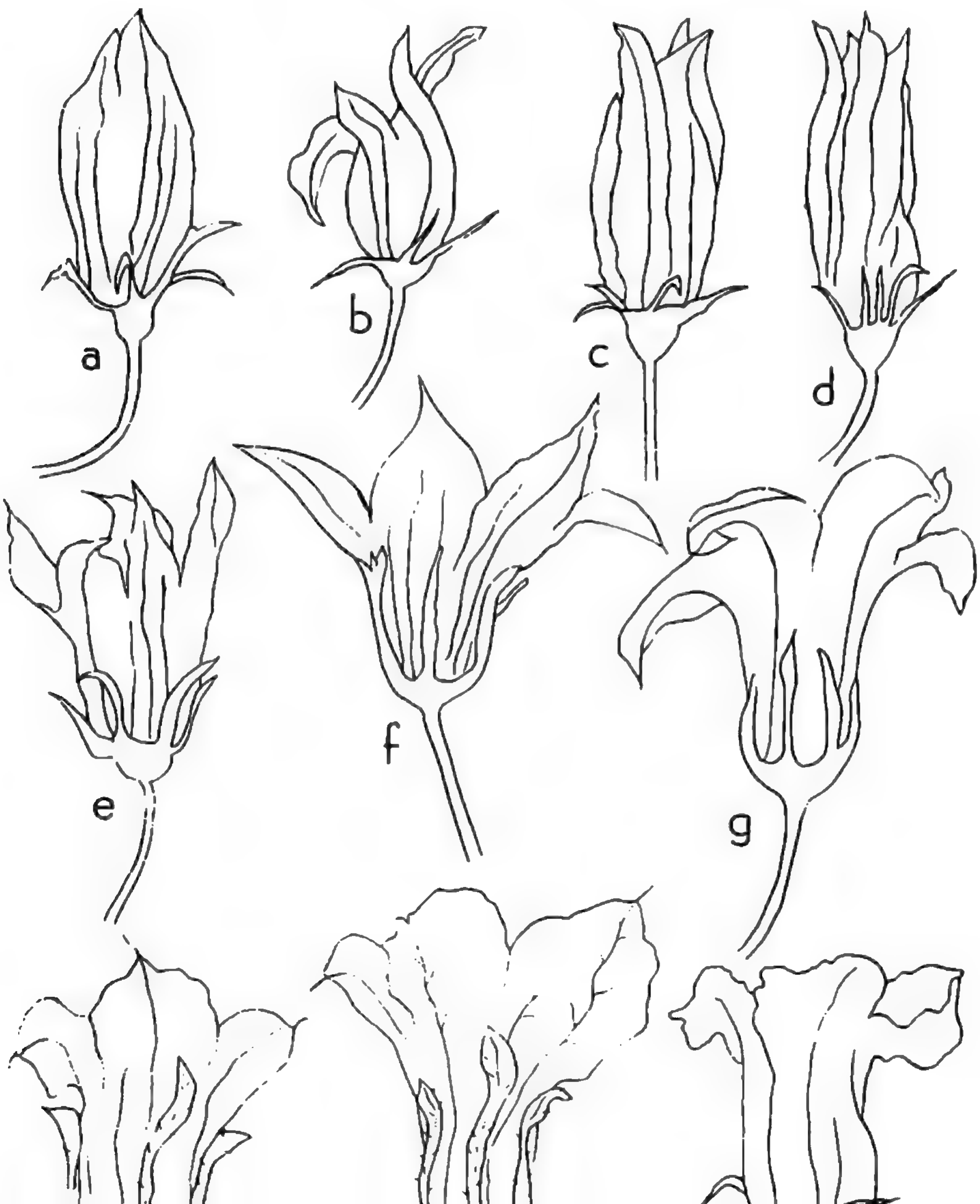


Table 3. Male flower characters

Material No.	Diameter of corolla (mm)	Length of corolla (mm)	Depth of sinus (mm)	Color	Length of peduncle (mm)	Diameter of peduncle (mm)	Shape of cross-section of peduncle	Length of sepal (mm)	Shape of sepal
112	69.2	71.5	40.7	dark-yellow	94.8	3.5	star	14.5	needle
706	76.9	84.4	41.4	yellow	61.3	4.0	〃	13.6	〃
782	100.9	80.4	39.0	dark-yellow	59.5	3.4	〃	14.9	〃
824	76.1	77.6	43.8	〃	49.8	3.4	〃	16.5	〃
1000	89.6	82.8	46.3	〃	105.8	3.7	〃	19.1	〃
788	95.8	101.7	42.3	yellow-orange	107.6	5.8	pentagon	38.3	stick
830	98.9	102.2	54.3	〃	123.9	4.6	〃	30.8	〃
998	90.6	88.2	43.5	〃	112.2	5.3	〃	37.9	〃
999	115.5	107.0	56.2	〃	119.0	5.9	〃	37.7	〃
113	54.6	76.0	28.3	pale-yellow	92.1	3.8	round	18.7	needle

istics of *C. maxima*.

4. Fruits

No. 112 (Fig. 8a): small and egg form; surface smooth, milk-white, warts not powdery, pericarp very hard; pulp white; ripe fruit fibrous and inedible. The fruit of *C. ovifera* (Fig. 10a) is almost similar to that of No. 112. Therefore this strain will be designated as *C. ovifera* or *C. Pepo* var. *ovifera*.

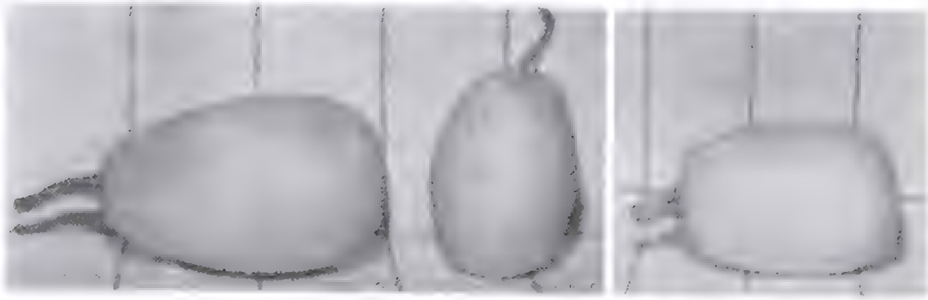
No. 706 (Fig. 8b): small and cylindrical; surface smooth, light-yellow, not powdery; pericarp very hard; pulp milky-white; ripe fruit very fibrous and inedible. In many respects, No. 706 is morphologically similar to *C. Pepo* var. *piriformis* (Fig. 10e), but the fruit is smaller.

No. 782 (Fig. 8c): small, longish-elliptical and bulged at the bottom; surface smooth, yellow-brown, not powdery; pericarp hard; pulp yellow-white, ripe fruit

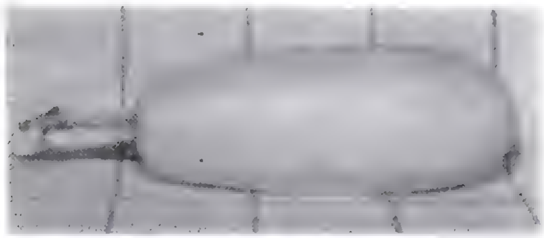
Table 4. Fruit characters

Material No.		112	706	782	824	1000	788	830	998
Fruit	form	egg	cylinder	longish-elliptical	longish-elliptical	oval	clabash	clabash	clabash
	width (cm)	10.7	12.1	10.2	9.3	10.7	14.5	13.8	15.8
	length (cm)	15.2	19.0	21.7	23.5	13.6	26.7	29.8	27.3
	size	small	small	small	small	small	middle	middle	middle
Pericarp	color	milk-white	light-yellow	yellow-brown	brown	yellow	bronze	bronze	bronze
	thickness (mm)	2.8	3.0	2.7	2.2	1.5	3.0	1.8	2.8
	structure	hard	hard	hard	soft	hard	soft	soft	soft
Stalk diameter (cm)		1.4	2.1	1.8	1.9	1.6	1.4	1.2	0.8
Sugar (%)		4.8	3.8	3.8	2.8	6.0	9.2	7.8	8.7
Sarcocarp	thickness (cm)	2.0	2.6	1.7	1.6	2.4	3.6	2.8	2.3
	color	white	milky-white	yellow-white	yellow-white	milky-white	orange	orange	orange

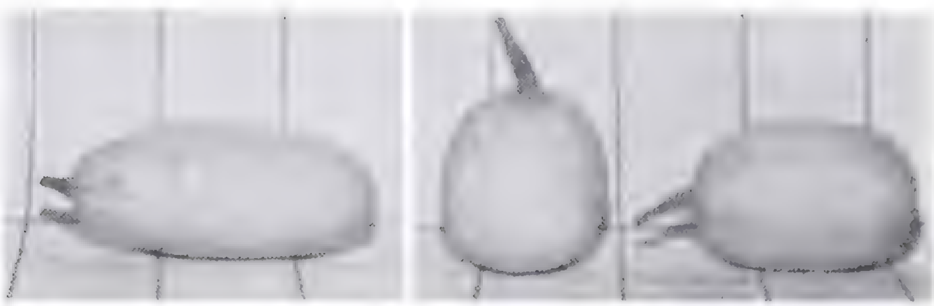
Common characters: Warts do not occur; pericarp is non-waxy.



a. No. 112 b. No. 706



c. No. 782



d. No. 824 e. No. 1000

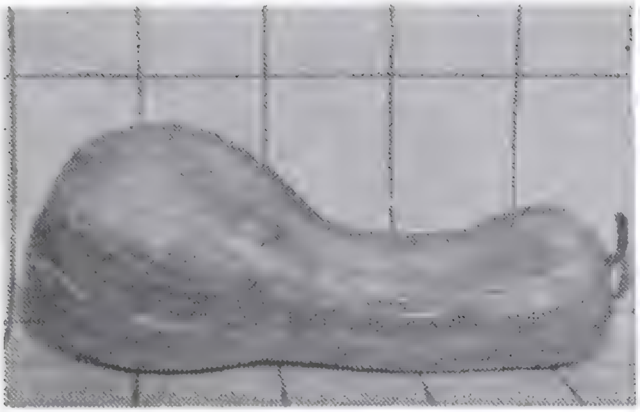
Fig. 8. Fruits of respective KUSE strains grown in Kyoto, Japan

bullate and vertically furrowed, powdery; pericarp soft, and pedestal thickend at the base; pulp orange, fibrous but edible, resembling "Tsurukubi", a variety of *C. moschata* but of poor quality.

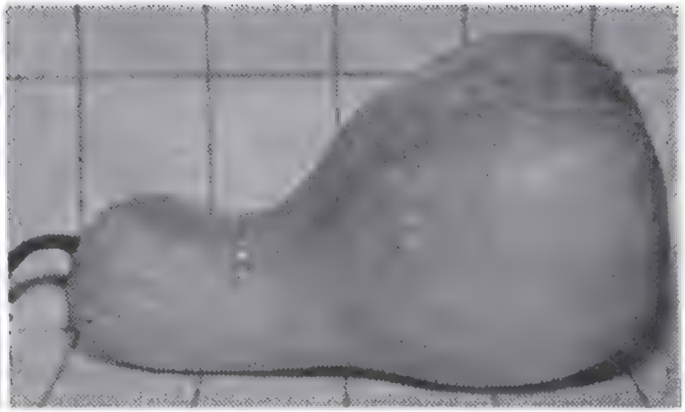
No. 830 (Fig. 6e, Fig. 9b), 998 (Fig. 9c) and 999 (Fig. 9d), resemble No. 788, but the fruit of No. 999 is longer than that of No. 998 and shorter than that of No. 788. The fruit of No. 830 is bulged at the bottom.

No. 113 (Fig. 9c): the biggest fruit weighs about 15 kgr; heart-shape; surface smooth, red and green patterns, and spongy at over-ripening; pulp yellow-white, edible with good quality, but not sweet enough.

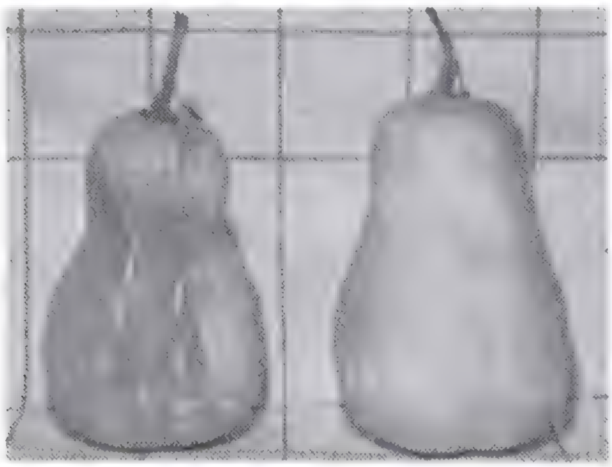
The fruits of Nos. 112, 706, 782, 824 and 1000 have non-powdery surfaces,



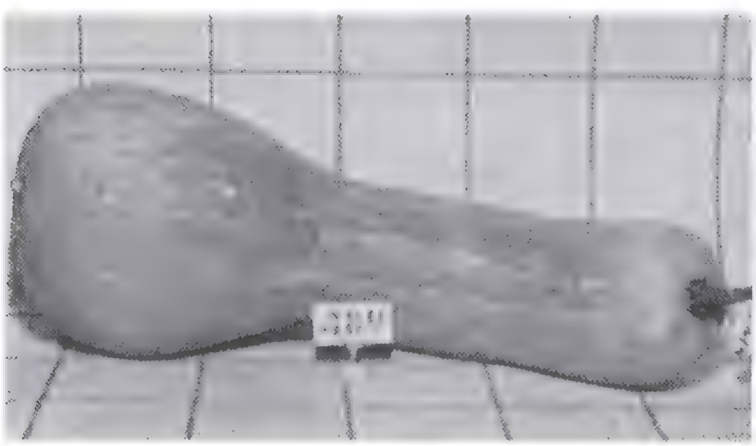
a. No. 788



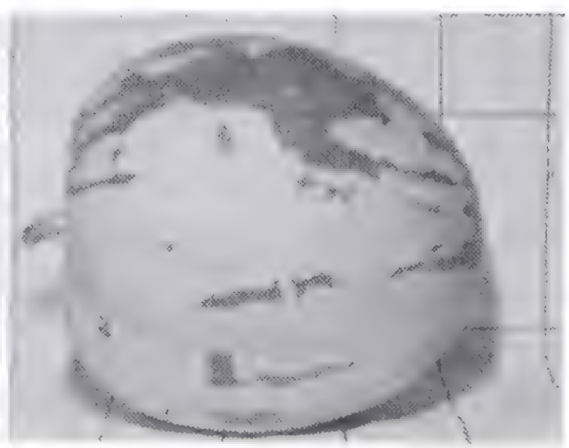
b. No. 830



c. No. 998



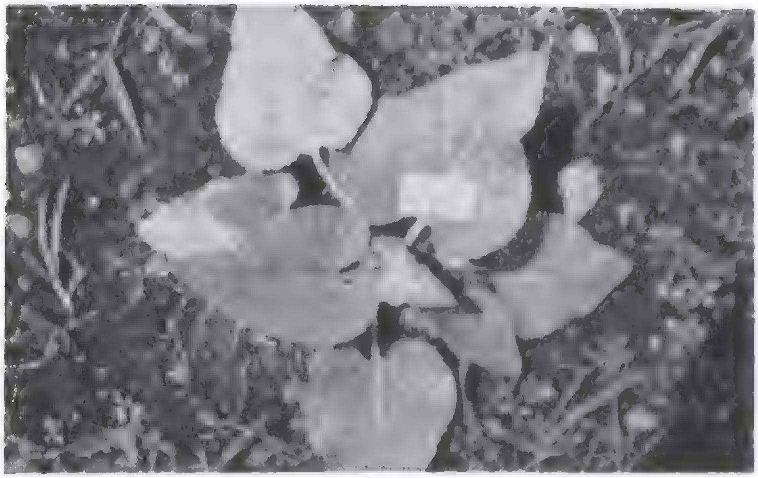
d. No. 999



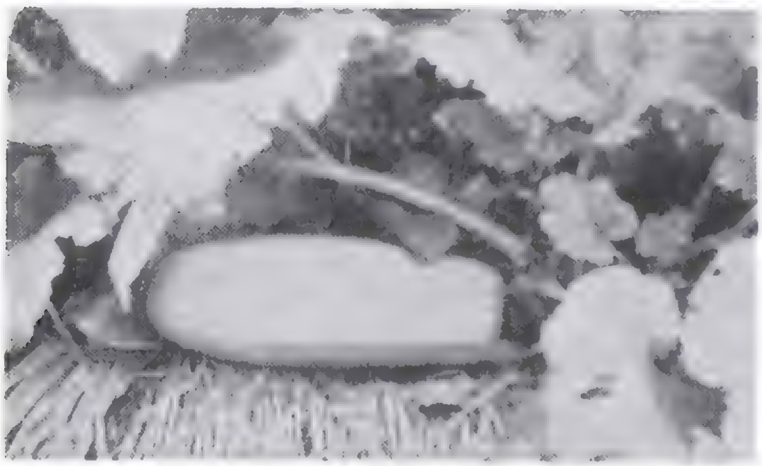
e. No. 113

Fig. 9. Fruits of respective KUSE strains grown in Kyoto, Japan

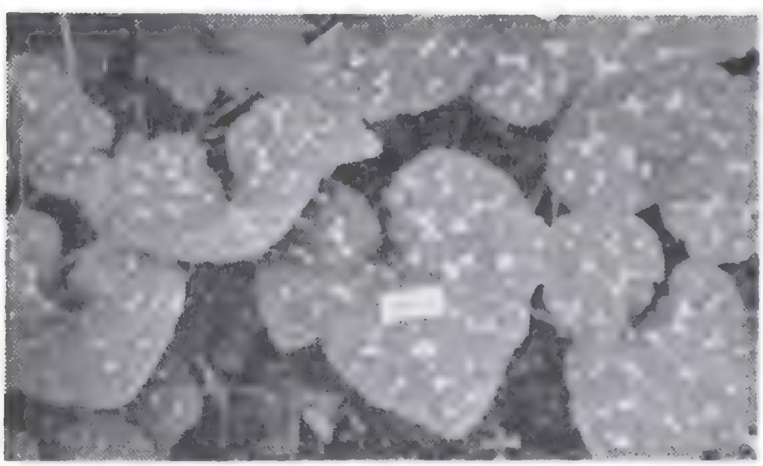
common food by the natives. Those native varieties would have been introduced from the Oriental and European countries through the communication exchanges



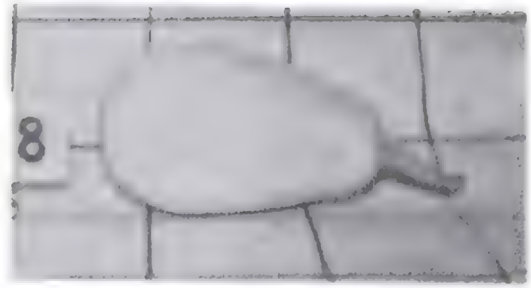
a. C. *foetidissima*



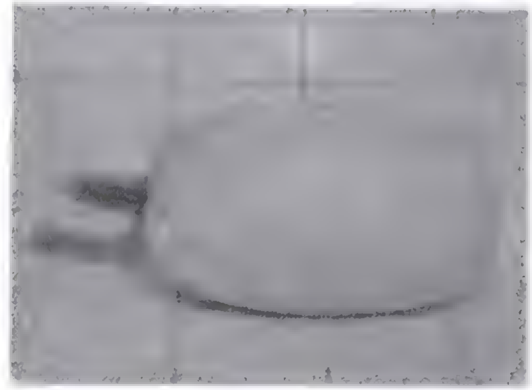
b. Shina-wase (Chinese-Early)



c. Brazil

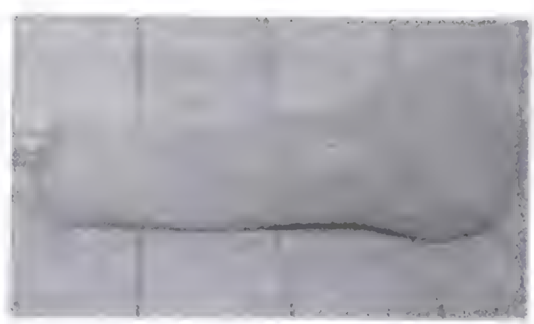


d. C. *ovifera*



e. C. *pririoform*

f. C. *cucurbilttela*



g. Brazil

Fig. 10. Growing habits and fruits of respective species and varieties in Kyoto, Japan

No. 112 was susceptible to mildew. No. 1000 showed necrosis as the tem-

6. Heat tolerance

The area of Iran and Afghanistan where the materials were collected lies on the latitude of middle Japan. The temperature is highest in July and August and lowest in December and January, and the temperature difference during each month is only 2~3°C. But the distribution of the lowest precipitation is different. The absolute precipitation is low there, but high in Japan.

All the collected examples, except No. 113, showed either the same or only a slightly lower heat tolerance as the Japanese varieties.

C. maxima grows best in a rather cool climate. Usually it shows a lower heat tolerance than the other species in Japan. No. 113 showed a very high heat tolerance. No decline in growth was observed even at the height of summer. This characteristic of No. 113 makes it possible for a breeding purposes of pumpkins in Japan.

7. Node position of male and female flowers

One of the recent breeding requirements is earliness, especially in forcing cultures. The earliness is known to be correlated to the lower node position of female flower.

C. Pepo (Nos. 112, 706, 782, 824, 1000): As shown in Table 5, the first female flower on the main vine in the bush-type tends to require fewer days from sowing until flowering than that of vine-type. The same relation in earliness between bush-type and vine-type was also observed in the Japanese cultivated *C. Pepo*. The first female flower of the Japanese bush-type variety flowered in 95 days, a little earlier than the introduced examples plants. Whereas the Japanese vine-type variety took approximately 78 days. No. 112 flowered 17 days earlier than the Japanese variety.

In conclusion No. 113 is inferior to the Japanese varieties in respect to the earliness of female flower initiation.

C. moschata (Nos. 788, 830, 998, 999): The introduced strains of *C. moschata*, are supposed to correspond to the domestic late maturing variety "Tsurukubi". The node position of the first female flower on the main vine was 2~7 nodes higher and flowering was 17 days later than the early maturing Japanese varieties. Also in the branch vine a similar tendency was observed: namely the first female

Table 5. Node position of flowers and flowering date (Date of sowing: April 13, 1956.)

Material No.	Main vine					Branch vine			
	First female flower		First male flower		Interval of female flowers*	First female flower		First male flow	
	Node position	Flowering date	Node position	Flowering date		Node position	Flowering date	Node position	Flow da
112	10	June 12	4	June 20	3. 89	9	June 13	1	July
706	13	〃 22	1	July 3	3. 67	11	〃 22	1	〃
782	9	〃 20	2	June 14	3. 00	3	July 12	1	〃
824	4	〃 14	1	〃 16	3. 20	4	〃 11	2	〃
1000	15	〃 27	5	〃 24	3. 31	9	June 23	1	〃
788	15	July 6	3	July 10	5. 15	14	July 12	1	〃
830	16	〃 7	3	June 28	4. 86	8	〃 8	1	〃
998	15	〃 7	3	July 7	4. 71	5	〃 9	1	〃
999	19	〃 10	2	〃 8	4. 00	11	〃 14	1	〃
113	23	〃 9	14	〃 12	4. 50	13	〃 1	9	〃

* Average number of internodes between female flower bearing nodes.

8. Sugar content

All the introduced strains showed a lower rate of sugar content than any of the Japanese varieties. The apporximate average sugar content was 4 percent in the varieties of *C. Pepo* while the variety, "Uccon", had a high rate at 8 percent. The strains of *C. moschata*. showed higher than 10 percent, for instance "Brazil" 10.9, and "Tsurukubi" 11.0. Among the introduced strains, No. 708 had the highest content at 9.2 percent. The percentage in "Mammoth", was low at 2.5~5 percent. No. 113 showed rather higher rate at 4.4 percent. Because of the lower sugar content in fruits of all the introduced strains, they will be of little use in Japan.

Conclusion

The area explored by the KUSE has been considered to be the centre of the origin of horse beans, peas, radish, carrot, spinach, Afghan-turnips and melons, but not to be the centre of the origin of pumpkins. For this reason the collected samples of pumpkins by the KUSE are of great interest. However, No. 1000 was the only one which showed some characteristics akin to the wild species, though it is not clear yet if it is really from the wild source.

The area of collections had been the historical place for communication between Oriental and European countries and therefore the present day varieties of the area would have been the ones introduced or established by the crossing of the original ones. The strains, which are recognized as *C. moschata* are close to the variety "Tsurukubi" cultivated in Southern Japan, Taiwan, Southern China, Philippines, Cambodia and India. This must be of Oriental origin. This resembles also the variety "Brazil", which is cultivated quite widely in Brazil and is supposed to have been introduced from the Orient.

Bisexual flowers occurred as the temperature rose in No. 788 frequently.

No. 782 and 824, recognized as *C. Pepo* of bush-type, will be included in the Vegetable Marrow-group. They are closely related to "Chinese-Early", which is cultivated in Japan with the name "Noodle-pumpkin". The leaves of Nos. 782 and 824 have slightly long-triangle shape, which is one of the characteristics found

The surface of a young fruit of No. 1000 is very much similar to that of wild pumpkin. The ripe fruit is not edible.

No. 113 belongs probably to the Mammoth-group. Its taste is not good but it will be useful for breeding a fodder variety since it is highly heat tolerant, and it flowers and bears fruits normally even during the hot summer season.

Summary

The present paper deals with the investigations on the materials of pumpkins collected by the Kyoto University Scientific Expedition (KUSE) to the Karakoram and Hindukush in 1956. The purposes were (1) to determine what species or varieties they belong to and (2) to find the useful characteristics for breeding purposes in Japan. The investigations have been carried out during three years from 1956 in the Department of Olericulture, Faculty of Agriculture, Kyoto Prefectural University, Kyoto, Japan.

(1). The data of the morphological studies will be summarized as follows:

Material No.	Species	Group	Related to
112	*C. Pepo* L.	Vegetable Marrow	*C. ovifera*
706	〃	〃	*C. piriformis*
782	〃	〃	Chinese-Early
824	〃	〃	〃
1000	〃	Wild	*C. cucurbittela*
788	*C. moschata* Duch.	Tsurukubi	Tsurukubi
830	〃	〃	〃
998	〃	〃	〃
999	〃	〃	〃
113	*C. maxima* Duch.	Mammoth	Mammoth, Fodder pumpkin

Japanese cultivated varieties, while No. 112, a runner variety, flowered 17 days earlier than the Japanese varieties.

C. maxima strains: were inferior to Japanese varieties.

C. moschata strains were the same as *C. maxima*.

(4) The node position of the first female flower was somewhat lower in all the strains than the Japanese varieties. It was lowest in No. 824.

(5) The sugar content of fruit was lower in all the strains than the Japanese varieties.

(6) All the materials used in the present experiments were the cultivated varieties collected from several districts in Afghanistan and Iran. They are supposed to have been introduced the during communications between the Orient and Europe or established by the natural crosses among them after their introduction. The material No. 1000 showed some morphological characteristics akin to wild species, but it is difficult to say whether or not it is really a primitive form.

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Cucumbers from Pakistan, Afghanistan and Iran

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In the present paper, morphological and ecological characteristics of eight strains of cucumber collected from Pakistan, Afghanistan and Iran by the Kyoto University Scientific Expedition (KUSE) to the Karakoram and Hindukush in 1955 are described in comparison with the Japanese varieties. The studies have been carried out in the Department of Horticulture and Agriculture, College of Agriculture, University of Osaka Prefecture, Sakai, Japan.

Material and Method

The cucumbers employed for the present studies are listed in Table 1. Among the Japanese varieties, "Taiwan-kema" belongs to a new hybrid strain related to the cucumber bred in North China, and "Daisen-fushinari No. 1" belongs to a strain in South China. The former is grouped as the summer variety and the latter as the spring variety in Japan.

Observations of the characters were made on the materials which were sown

Table 1. List of cucumbers collected from Pakistan, Afghanistan and Iran

Material No.	Locality		Collector
110	Kabul,	Afghanistan	H. KIHARA
768	Tehran,	Iran	K. YAMASHITA

on March 16 and transplanted on April 13, 1956. Eight plants of each strain were planted at the distance of 45 cm in 60 cm wide rows according to the randomized method in a greenhouse. The main vine was grown vertically and prunned when the 20th leaf expanded, so that the lateral vines grew strongly. Several pistillate flowers of a plant were selfed artificially or cross-pollinated. Three fertilized fruits were allowed to grow to full maturity on each plant and the others were thined out.

Observation

Results of observation are summarized in Tables 2 and 3.

1) Seed characters

Seeds and cotyledons of the KUSE cucumbers were larger than those of any Japanese varieties.

2) Leaf characters

Size of the leaf was measured from the blades of the ninth to the 11th node on main vine. Leaves of the KUSE cucumbers were larger and more sharply pointed, but no conspicuous difference was seen in the proportion of the width

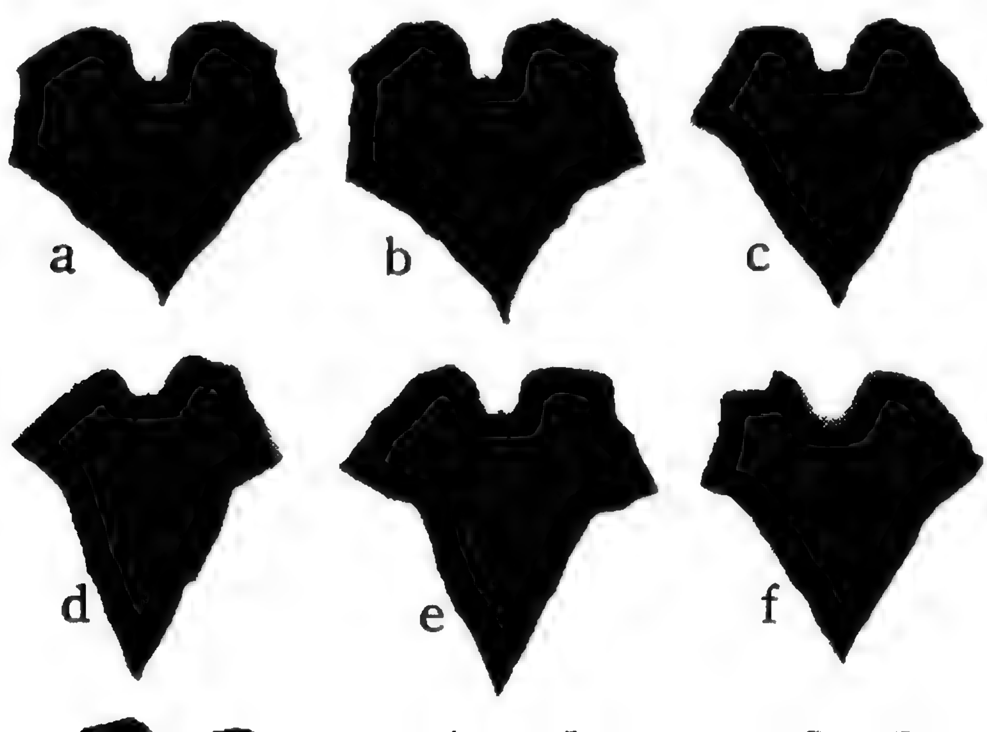


Table 2. Characteristics of cucumbers collected from Pakistan, Afghanistan and Iran

Item	KUSE material								Jap. var.[1]	
	110	768	806	822	1004	1006	1153	1156	Tk	Df
Seed:										
length (mm)	11	12	12	12	14	13	10	10	9	8
width (mm)	4	4	4	4	5	5	4	4	4	4
100 seeds weight (gr)	3.1	4.0	4.2	4.3	4.4	3.9	3.3	3.1	3.2	3.1
Viable seeds per fruit	281	229	208	203	302	268	276	521	68	201
Cotyledon:										
length (mm)	51	64	68	60	71	50	58	52	46	45
width (mm)	25	29	30	27	29	25	28	29	23	23
Leaf:										
length (cm)	20	24	24	23	23	23	22	22	20	19
width (cm)	24	26	26	28	29	26	25	26	24	23
Vine:										
internode length (cm)	9	7	6	9	10	9	9	10	11	10
thickness (mm)	8	7	6	8	9	7	7	7	7	7
plant height (m)	1.7	1.3	1.1	1.5	1.9	1.8	1.7	1.7	2.2	1.6
Ovary:										
length (mm)	18	20	16	16	22	22	21	22	40	26
diameter (mm)	7	7	6	7	8	6	7	9	5	5
spine color[2]	B	B	B	B	B	B	B	B	W	B
Fruit of marketable size:										
skin color[2]	DG	DG	G	LG	G	G	G	LG	DG	LG
fruit surface[3]	W	RW	S	S	RW	RW	W	S	W	W
Fully matured fruit for seed:										
skin color[2]	Br	OB	Br	YB	Br	Br	BB	YB	YB	Br
weight (g)	410	580	640	630	970	870	790	670	660	630
length (cm)	14	17	16	16	20	23	19	16	44	32
diameter (cm)	8	8	9	9	10	8	9	9	5	6
length/diameter	1.8	2.1	1.8	1.8	2.0	2.9	2.1	1.8	8.8	5.3
netting[4]	H	S	H	H	H	H	H	H	N	S
flesh thickness (mm)	12	15	16	17	19	16	16	13	12	13

Table 3. Flower-bearing habit in cucumbers collected from Pakistan, Afghanistan and Iran

Item	KUSE material								Jap. var.	
	110	768	806	822	1004	1006	1153	1156	Tk	Df
Main vine:										
Node location of 1st male flower	1	1	1	1	1	1	3	2	1	1
Days after sowing to flowering of 1st male flower	44	44	43	44	45	51	50	52	50	53
Node location of 1st female flower	14	7	6	11	10	12	11	—[3]	13	11
Days after sowing to flowering of 1st female flower	58	47	42	52	53	58	54	—[3]	61	62
Number of nodes with female flower[1]	2.3	2.0	3.7	2.0	3.3	2.0	1.0	0	2.0	15.0
Number of nodes with male flower[1]	22.7	23.0	21.3	23.0	21.7	23.0	22.0	24.0	23.0	10.0
Rate of nodes with female flower to all nodes (%)[1]	9.2	8.0	14.8	8.0	13.2	8.0	4.0	0	8.0	60.0
Lateral vine:										
Number of lateral vines with expanded leaf[2]	6.0	5.7	5.7	6.7	8.3	4.0	8.3	12.0	8.5	3.1
Number of nodes with female flower[2]	12	12	15	10	12	16	32	20	21	12
Number of nodes with male flower[2]	43	54	28	34	56	43	66	119	93	0
Rate of nodes with female flower to all nodes (%)[2]	21.8	18.2	34.9	22.7	17.7	27.1	32.7	14.4	18.4	100
Rate of lateral vines with female flower on 1st node to all lateral vines[2]	55	30	78	44	16	90	83	68	61	100
Days from sowing till expanding the 20th leaf on the main vine	64	59	54	61	64	64	49	53	67	—

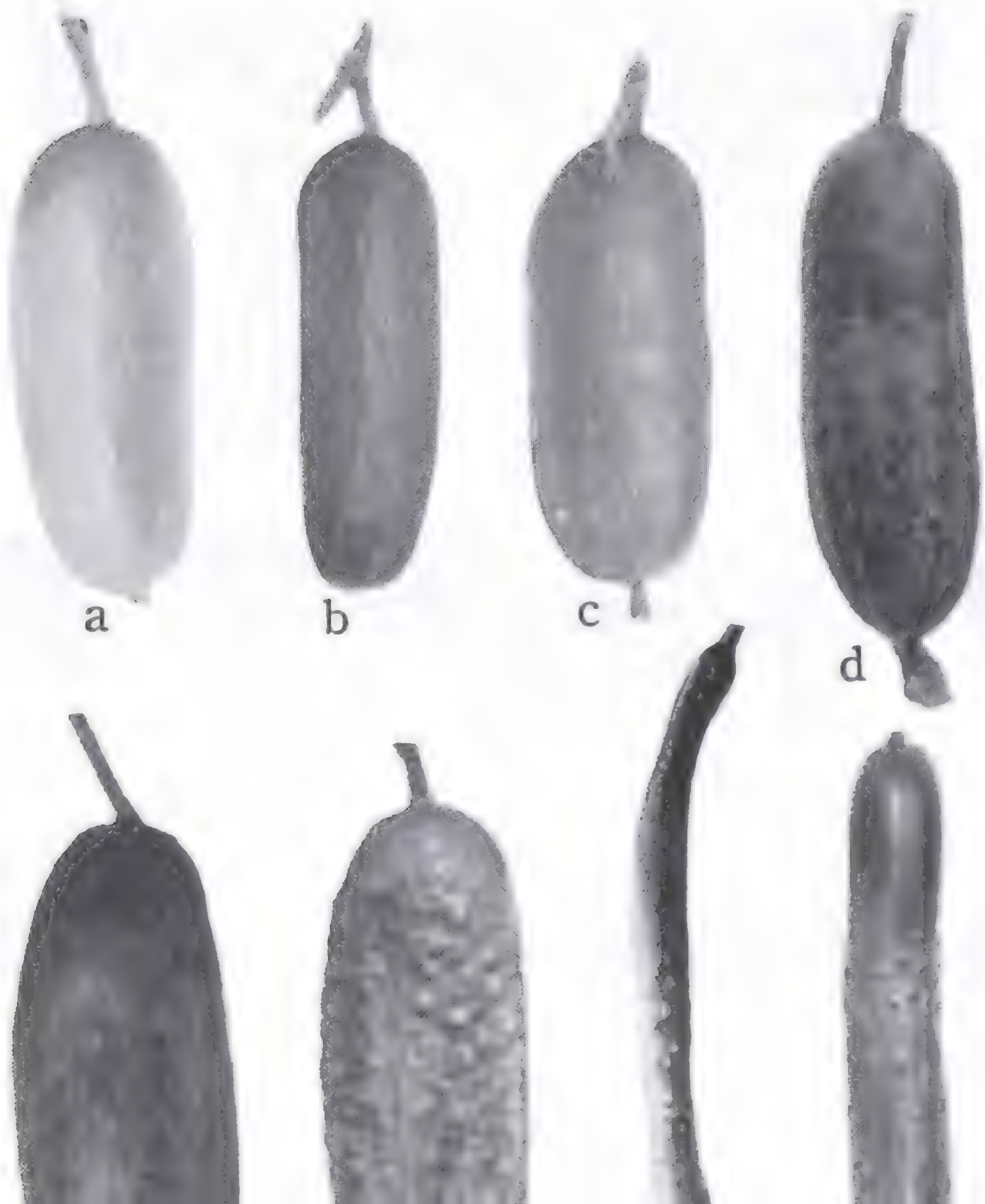
1) Observed up to the 25th node on main vine.
2) Counted when the 20th leaf expanded on the main vine.
3) No female flower was found by the end of the present investigations.

to the length between the KUSE cucumbers and the Japanese varieties. Middle

and therefore the plant height in the former was about one meter less than the latter.

4) Inflorescence

All the cucumbers used in the present study were monoecious, bearing staminate or male flowers and pistillate or female flowers. Pistillate flower occurred singly, and the staminate flowers occurred in a cluster on a node. Two kinds of flowers rarely occurred on the same node. The flower organs of the KUSE cucumbers were larger than the Japanese varieties.



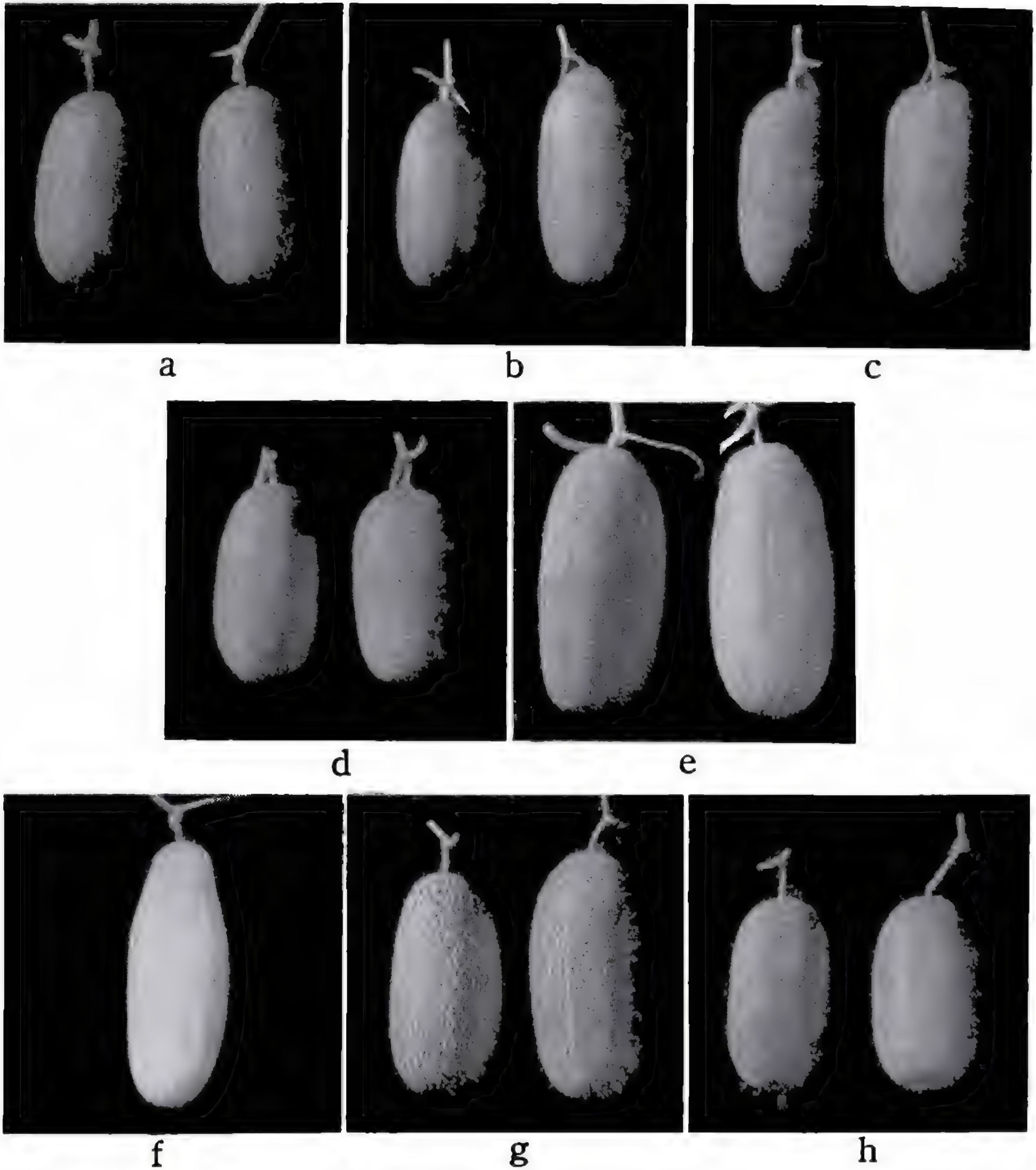


Fig. 3. Fully matured fruits ×1/6

a. No. 110, b. No. 768, c. No. 806, d. No. 822,
e. No. 1004, f. No. 1006, g. No. 1153, h. No. 1156

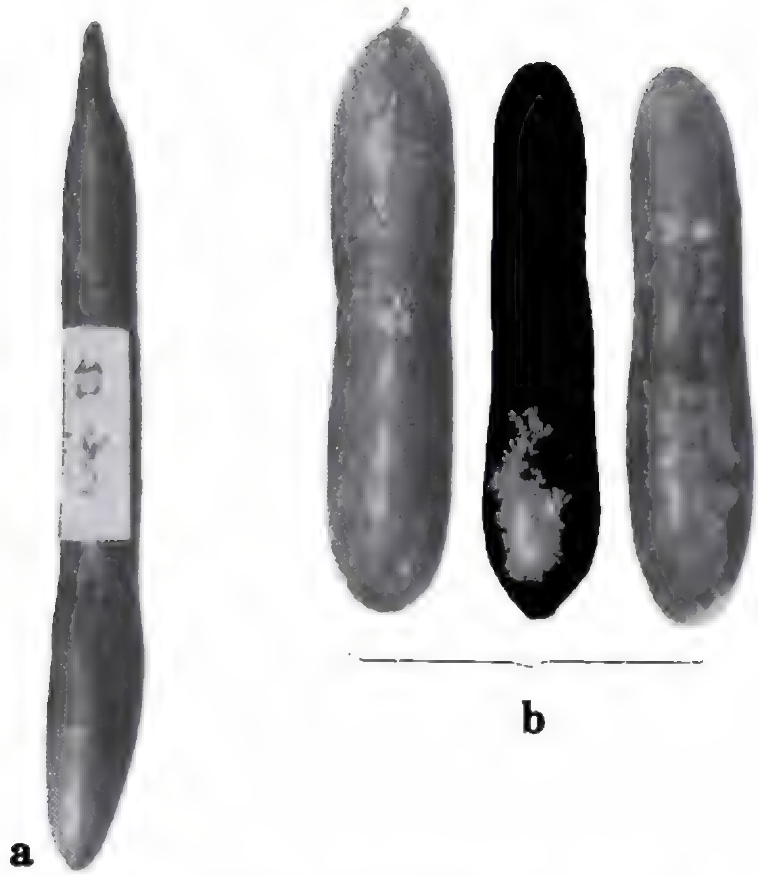


Fig. 4. Fully matured fruits ×1/6

a. "Taiwan-Kema", b. "Daisen-fushinari No. 1"

skin color, presence of stripe, roughness of the surface, and turning to yellowish- or blackish-brown at maturity. Netting of fully mature fruit was heavy in most of the KUSE cucumbers, but none or slight in the Japanese varieties. Pedicel was shorter, and flesh of fruit was remarkbly thick, especially in Nos. 1004 and 822.

6) Growth habit in a greenhouse

Generally, the KUSE cucumbers were vigorous and grew earlier. The formation of lateral vines varied from few to numerous. The cultivation was easy in a greenhouse during the spring time.

7) Flower bearing habit

The first staminate flower occurred on the first node on the main vine in most strains. Node locations of the first pistillate flower on the main vine varied with strains, for instance, in No. 806 it was the sixth and in No. 768 the seventh, both being lower than in the Japanese varieties. All the KUSE strains, with the

node on the lateral vine, only two nodes with pistillate flower were observed on the main vine.

Bearing habit of pistillate flowers on the lateral vines greatly differed among strains. For instance the rate of the number of nodes with pistillate flowers to the total number of the nodes on a lateral vine was 14 per cent in No. 1156, while it was 35 per cent in No. 806. The same with "Taiwan-kema" was about 18 per cent, while in "Daisen-fushinari No. 1" a pistillate flower was produced on every node on every lateral vine.

Flowering dates of both pistillate and staminate flowers of the KUSE cucumbers were earlier than the Japanese varieties. The tendency was most striking in No. 806.

8) Crossing experiments

Many viable seeds were obtained in all reciprocal crosses between the KUSE cucumbers and the Japanese varieties. Number of seed per fruit in "Taiwan-kema" was few both in crossing and selfing. All the KUSE cucumbers did not develop fruit normally without pollination.

Consideration

The KUSE cucumbers seemed to be not suitable for practical cultivation in Japan, because of thick cylindrical fruit shape and skin color that turns early which is not popular in markets. However, the new bush- or dwarf-type will possibly be used for forcing cultures under glass, plastic film or cloche, which will possibly be developed from the crosses between No. 806 with short internode and the Japanese varieties.

Botanical or horticultural classification of the KUSE cucumbers is not clear, because no cross incompatibility has been found among the botanical varieties of *Cucumis sativus*, and many of their characters are common. Furthermore, the origin or history of the KUSE examples in respective habitats is uncertain. Most of them, however, resemble var. *sikkimensis* (a Sikkim cucumber) cultivated in the Himalayan Mts., better than var. *anglicus* (an English forcing cucumber).

Melons from Pakistan, Afghanistan and Iran

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Introduction

Muskmelon has been grown as a glasshouse crop in Japan for about 60 years but its commercial culture is of comparatively recent development. Numerous varieties of melons have been introduced from Europe, especially from England. The most popular type of muskmelon on the Japanese market is one with green flesh, globular and heavily netted fruit, that is Earl's Favourite (Fig. 1). The history of the commercial melon culture of Japan has begun with the Earl's Favourite. This was developed by CARTERS Seed Co. Ltd. in England, and was introduced to Japan by K. HARADA in 1924. However, Earl's Favourite has not been suitable enough because of its late ripening, poor keeping quality, lack of

flavor, and difficulty of pistillate flower formation under the long-day and high temperature conditions in summer. The improvement of melon by means of crossing using this variety, has been attempted by many breeders, and consequently two varieties, "Okitsu" and "Pearl", were released in 1948. But still they did not meet the market preference.

In 1955, the Kyoto University Scientific Expedition (KUSE) to the Karakoram and Hindukush, introduced melon seeds from Pakistan, Afghanistan and Iran. It has been thought that melon is indigenous in central Asia and Africa, and that the area including Pakistan, Afghanistan and Iran is one of its original centers.

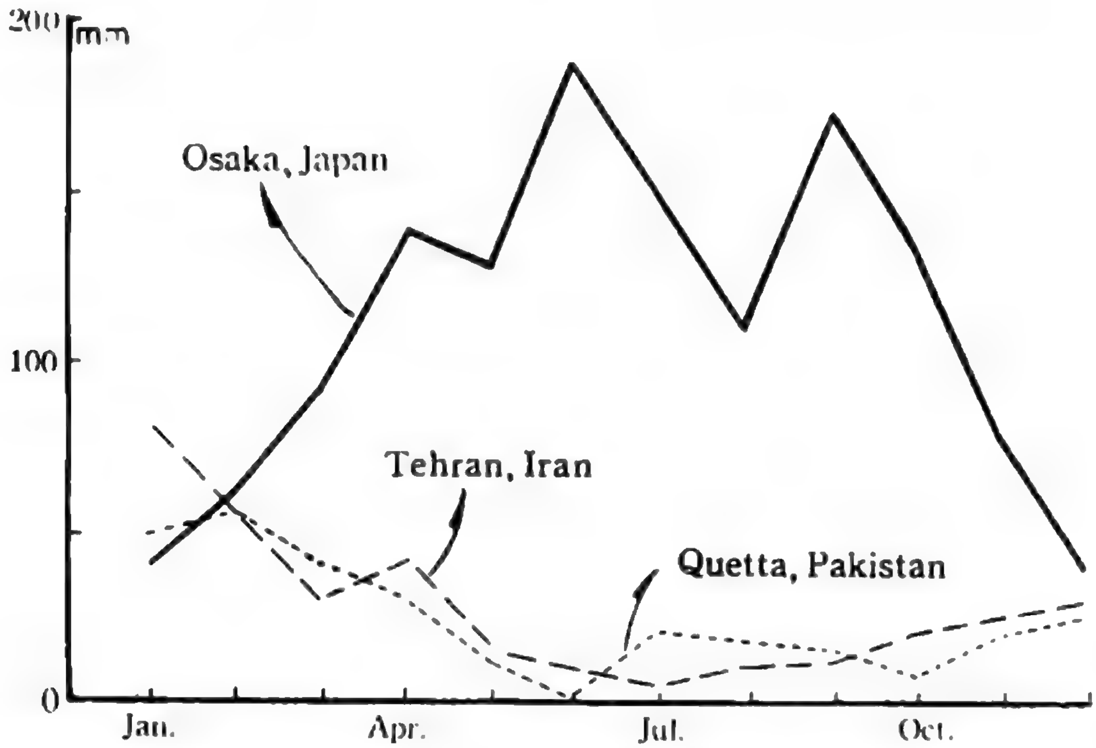


Fig. 2. Monthly trends of the average rainfall in Osaka, Tehran and Quetta

The area is located between the latitudes of 29°N to 40°N. Japan lies between the latitudes of 30°N and 45°N. Temperature and rainfall are shown in comparison in Figs. 2 and 3. There is a marked difference in rainfall, especially during June, July and September. Due to the high humidity Japan may be unfavorable for the cultivation of melons introduced from such arid area.

The present studies have been designed to compare those KUSE strains with the Japanese leading varieties under glasshouse conditions, and to find characteristics useful for the improvement of muskmelon in Japan. The present studies have been conducted in a glasshouse of the Department of Horticulture and Agriculture, College of Agriculture, University of Osaka Prefecture, Sakai, Japan, 1956~1957.

Material and Method

The materials of the present studies are 31 strains of melon (*Cucumis melo* L.) brought to Japan by the Kyoto University Scientific Expedition (KUSE) to the Karakoram and Hindukush in 1955, and Earl's Favourite (*Cucumis melo* L. var. *reticulatus* NAUD.). The KUSE materials are presented in Table 1.

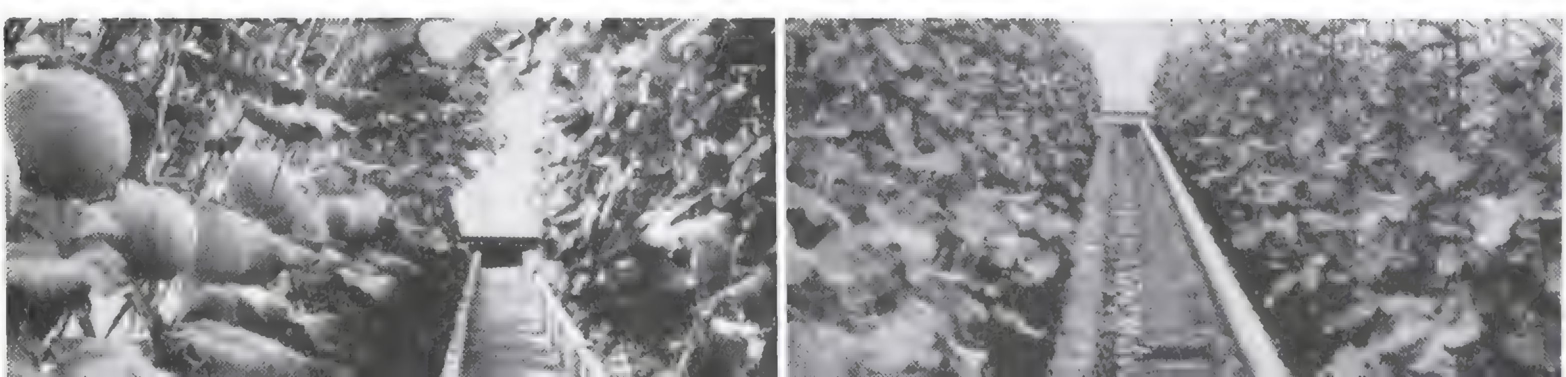
Table 1. Strains of *Cucumis melo* used

KUSE No., collector*		Locality		Remarks by KUSE
76	N	Skardu,	Pakistan	
82	N	Minapin,	〃	
111	K	Kabul,	Afghanistan	
150	K	〃	〃	
242	K	Shahrud,	Iran	Fruit round, green stripe, flesh white, sweet
505	K	Gorgan,	〃	Fruit oblong, skin yellow-green, flesh red, taste not bad
506	K	Shahrud,	〃	Fruit round, skin yellow-green, flesh white
507	K	〃	〃	Fruit round, skin light-green, flesh green, sweet

Table 1 (Continued)

766	Y	Tehran,	Iran	
770	Y	〃	〃	
775	Y	〃	〃	
776	Y	〃	〃	
980	KT	Kabul,	Afghanistan	Skin black
981	KT	Quetta,	Pakistan	Fruit oblong, flesh salmon-pink
982	KT	〃	〃	Fruit oblong, skin yellow-green, flesh green
983	KT	〃	〃	Skin yellow, rib dark-green, flesh salmon-pink
984	KT	〃	〃	Fruit round, flesh salmon-pink
985	KT	〃	〃	Fruit round, flesh pale-green
986	KT	Kandahar,	Afghanistan	
987	KT	Mazar-i-Sharif,	〃	
988	KT	〃	〃	Fruit round, large
989	KT	〃	〃	Fruit round
990	KT	Pakistan		Fruit oblong, skin yellow-green, slightly acid
1003	KT	Kandahar,	Afghanistan	
1005	KT	Mazar-i-Sharif,	〃	

* N: S. NAKAO, K: H. KIHARA, Y: K. YAMASHITA, KT: S. KITAMURA.



The Japanese common procedure of cultivation was applied throughout the present investigations (Fig. 4). Seeds were sown in flats containing sterilized sand in a glasshouse on March 14, 1956, and after six days seedlings were transplanted into 12 cm clay pots one by one. When the third true leaves expanded, they were planted in a bed of a fertile loam in a glasshouse at 45 cm distance in 45 cm wide rows, arranged randomly. Observations were made of three plants in each strain.

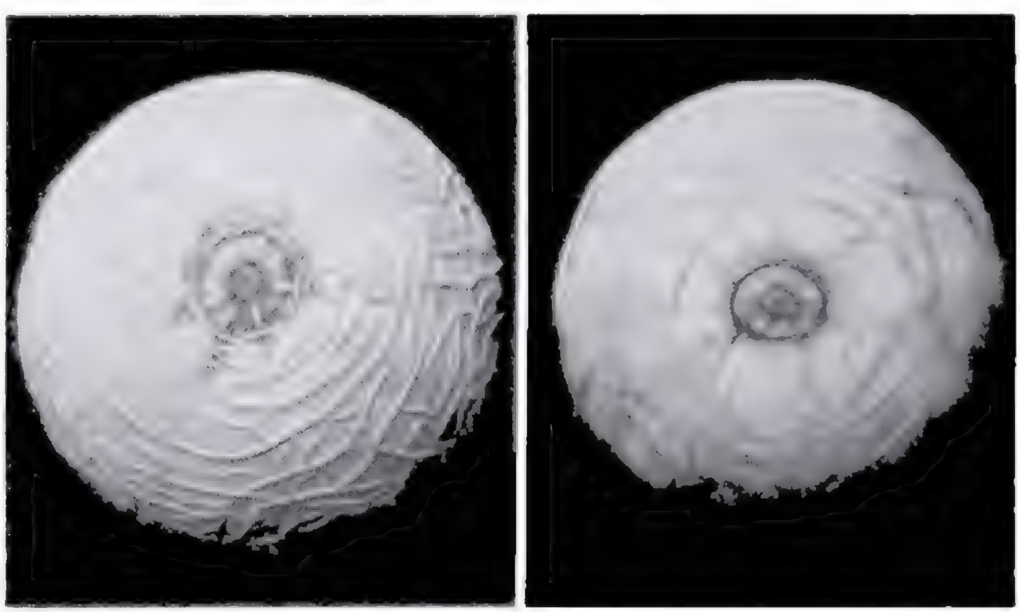
In 1956, the crosses were made between the KUSE strains and Earl's Favourite and the F_1 seeds were sown in the glasshouse on February 13, 1957. Ten plants of each of the F_1 hybrids between Nos. 82, 111, 150, 242, 701, 705, 981, 1003 and Earl's Favourite, and ten plants of the parents were employed for the present investigations.

Results and Consideration

A. Morphological and ecological observations

1. Fruit characters:

(a.) KUSE strains—The fruits were harvested when the symptom of abscission was seen around the attachment (Fig. 5) known as "Full-slip". While, no such



a b

Fig. 5. Comparison of shed and unshed melon fruits at maturity

Table 2. Characteristics of fruit (1956)

Item	Earl's Favourite	No. 79	No. 82	No. 111	No. 150	No. 242
Days from flowering to harvesting	53	46	40	47	42	45
Slip at maturity	none	easy	easy	none	easy	none
Crack at maturity	none	none	rather easy	none	easy	none
Shape	globular	globular or club*	oblong	cylindrical	oblong	flat
Diameter (cm)	13	11	9	9	11	15
Length (cm)	14	17～23*	19	160	17	12
Weight (gr)	1400	1000	900	4000	1000	1400
Color of skin	grayish-green	creamy-white	orange-yellow	creamy-white	yellow-blotchy	yellow
Net	dense	none	sparse	none	sparse	none
Rib	none	none	deep or none*	furrowed	none	none
Pubescence at maturity	smooth	heavy	heavy	none	heavy	smooth
Diameter of blossom scar (mm)	15	5	17	5	2. 8	18
Thickness of flesh (cm)	3. 1	1. 3	1. 6	1. 8	1. 9	2. 3
Color of flesh (inner)	yellowish-green	salmon-pink	salmon-pink	white	orange	white
Soluble solids**	12. 0	6. 5	7. 0	2. 0	10. 0	11. 1
Flavor	musky-weak	musky-weak	squash-like	cucumber-like	musky	musky-weak
Quality of flesh	fine	juicy	coarse	mealy, inedible	rigid, juicy	fine, juicy
Acid taste at maturity	none	none	none	slight	none	none
Bitterness of immature fruit	none	none	bitter	none	none	none

Table 2. (Continued)

No. 505	No. 506	No. 507	No. 508	No. 701	No. 702	No. 705	No. 707
36	38	36	37	37	42	44	40
easy	easy	easy	easy	easy	easy	easy	easy
easy	easy	easy	easy	easy	easy	none	none
oblong	globular	globular	globular	flat	flat	globular	globular
12	15	14	11	13	14	14	8
19	16	14	11	10	11	13	9
1100	1500	1200	700	900	1000	1100	400
orange-yellow	orange-yellow	yellow	yellow	yellowish-green	yellowish-green	orange-yellow	yellow
sparse	sparse	sparase	sparse	dense	dense	dense	none
none	shallow	deep	deep	shallow	shallow	deep	none
heavy	heavy	heavy	heavy	heavy	heavy	heavy	heavy
9	18	7	19	12	14	26	16
2.3	20	1.9	2.3	1.8	1.8	1.9	0.9
salmon-pink	white	pale-green	white	white	green or white*	salmon-pink	salmon-pink
7.0	3.0	5.0	11.0	8.0	9.0	5.0	4.0
musky	musky	musky	musky	musky	musky	musky	musky
—	—	coarse	mealy, coarse	coarse, juicy	coarse, juicy	juicy	—
none	none	none	none	none	none	none	none
none	none	none	none	none	none	bitter	none
2.0	3.0	2.5	1.5	3.0	3.0	3.3	3.0

Table 2. (Continued)

No. 764	No. 766	No. 775	No. 776	No. 980	No. 981	No. 982	No. 983
43	34	38	41	—	36	41	39
easy	easy	easy	easy	easy	easy	easy	easy
none	easy	easy	none	none	easy	none	easy
oblong	globular or oblong*	globular	globular	flat	oblong	oblong or club*	oblong
12	12	13	12	12	9	8	11
16	15	13	12	8	18	15	19
900	1100	1000	800	600	700	500	900
yellow-blotchy	orange-yellow or yellow*	orange-yellow	orange-yellow	brown	yellow	orange-yellow	yellow
dense or sparse*	sparse	dense	dense	none	none	none	sparse
none	deep or none*	deep	deep	none	shallow	deep	shallow or none*
heavy or smooth*	heavy or smooth*	heavy	heavy	smooth	heavy	heavy	heavy or smooth*
5~27*	6~26*	50	7	40	3	5	10
2.0	1.9	1.9	1.5	1.6	1.5	1.1	1.4
pale-green or salmon-pink*	white	salmon-pink	pale-green	green	salmon-pink	pale-green or salmon-pink*	salmon-pink
7.0	4.0	5.0	5.0	8.5	8.0	3.5~7.5*	8.5
musky	musky-weak	musky	musky	Makuwa-like	Makuwa-like	Makuwa-like	Makuwa-like
—	—	coarse	coarse, juicy	—	mealy	mealy	mealy
none	none	none	none	none	none	none	slight
bitter	bitter	none	none	bitter	bitter	bitter	bitter
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 2. (Continued)

No. 984	No. 985	No. 986	No. 987	No. 988	No. 989	No. 990	No. 1003	No. 1005
33	35	—	45	—	45	39	37	37
easy	easy	easy	—	—	easy	easy	easy	none
none	none	easy	—	—	none	none	none	none
flat	oblong	oblong	oblong	oblong	oblong	oblong	cylindrical	cylindrical
12	10	14	7	9	10	5～11*	9	9
10	20	17	15	15	17	13～18*	44	104
700	900	1700	—	—	700	200～1000*	1500	2400
orange-yellow	yellow	orange-yellow-blotchy	—	—	orange-yellow-blotchy	yellow	creamy-white	green
sparse	none	sparse	sparse	—	sparse	none	none	none
deep or shallow*	none	none	shallow	—	none	deep	none	none
smooth	heavy	sparse	heavy	heavy	heavy	heavy	heavy	smooth
39	7	31	10	16	21	2～18*	2	3
1.5	1.4	2.2	1.0	—	1.0	1.5	1.1	1.4
salmon pink	white or salmon-pink*	green	white	—	pale-green	white	white	salmon-pink
8.0	4.0	4.0	—	—	7.5	4.0	5.5	2.5
musky	Makuwa-like	musky	Makuwa-like	—	Makuwa-like	Makuwa-like	Makuwa-like	cucumber-like
mealy	—	—	mealy	—	juicy	juicy	rigid	rigid
none	none	none	none	—	none	slight	slight	slight
bitter	none	none	none	—	none	bitter	none	none
5.0	4.5	3.0	4.3	2.2	2.5	4.5	8.3	5.6

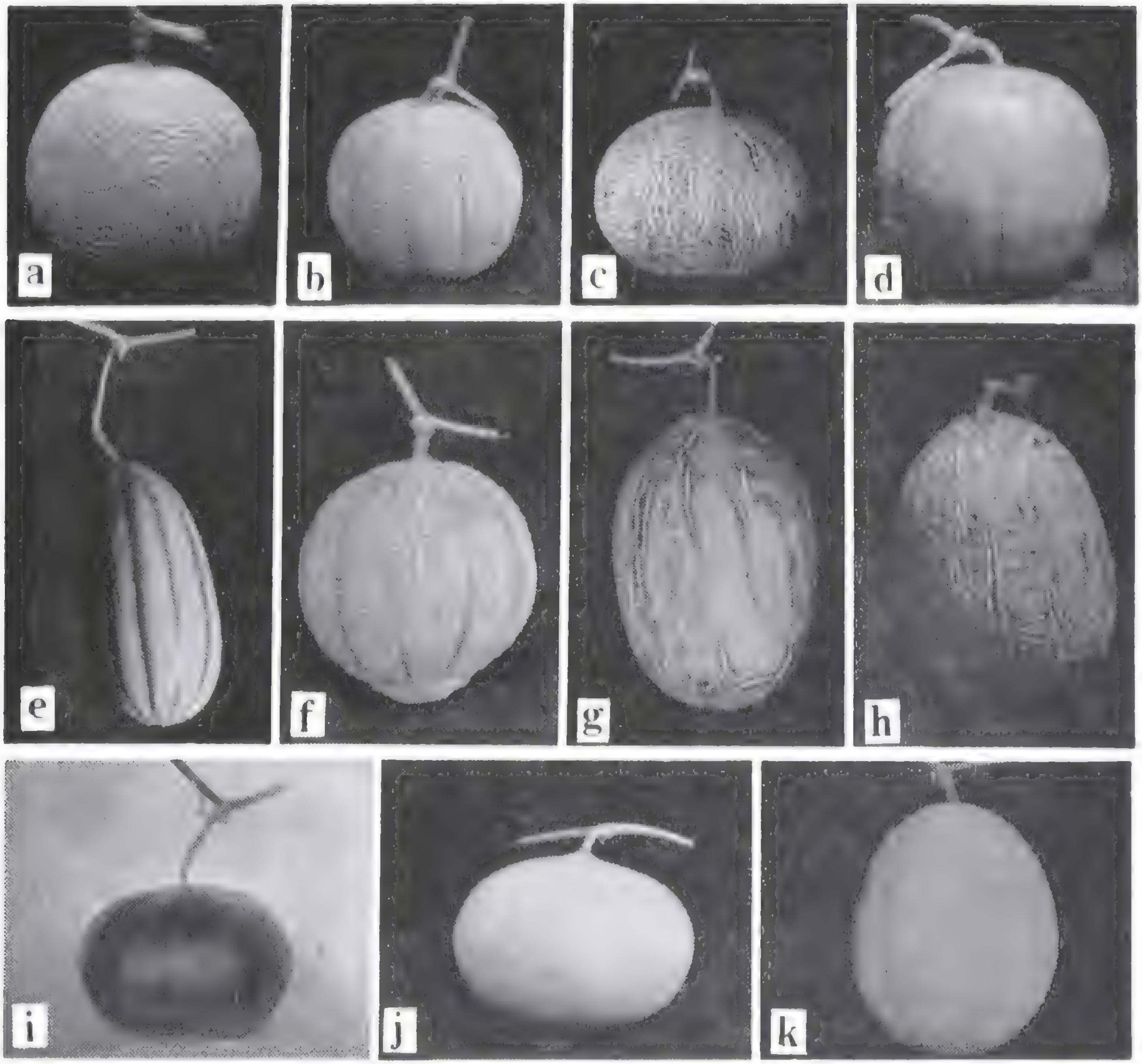


Fig. 6. Representative fruit forms of Earl's Favourite and the KUSE strains

a~h. Netted melons (var. *reticulatus* NAUD.):
a. Earl's Favourite, b. No. 776, c. No. 702,
d. No. 507, e. No. 82, f. No 775, g. No. 766, h. No. 986
i~k. Winter melon (var. *inodorus* NAUD.):
i. No. 980, j. No. 242, k. No. 79

Favourite), or white flesh (No. 242) and green flesh, flesh was tinted from green to salmon-pink or white adjacent to cavity.

Genetical studies of *C. melo* were made by LUMSDEN (1914), MCCLELLAND *et*

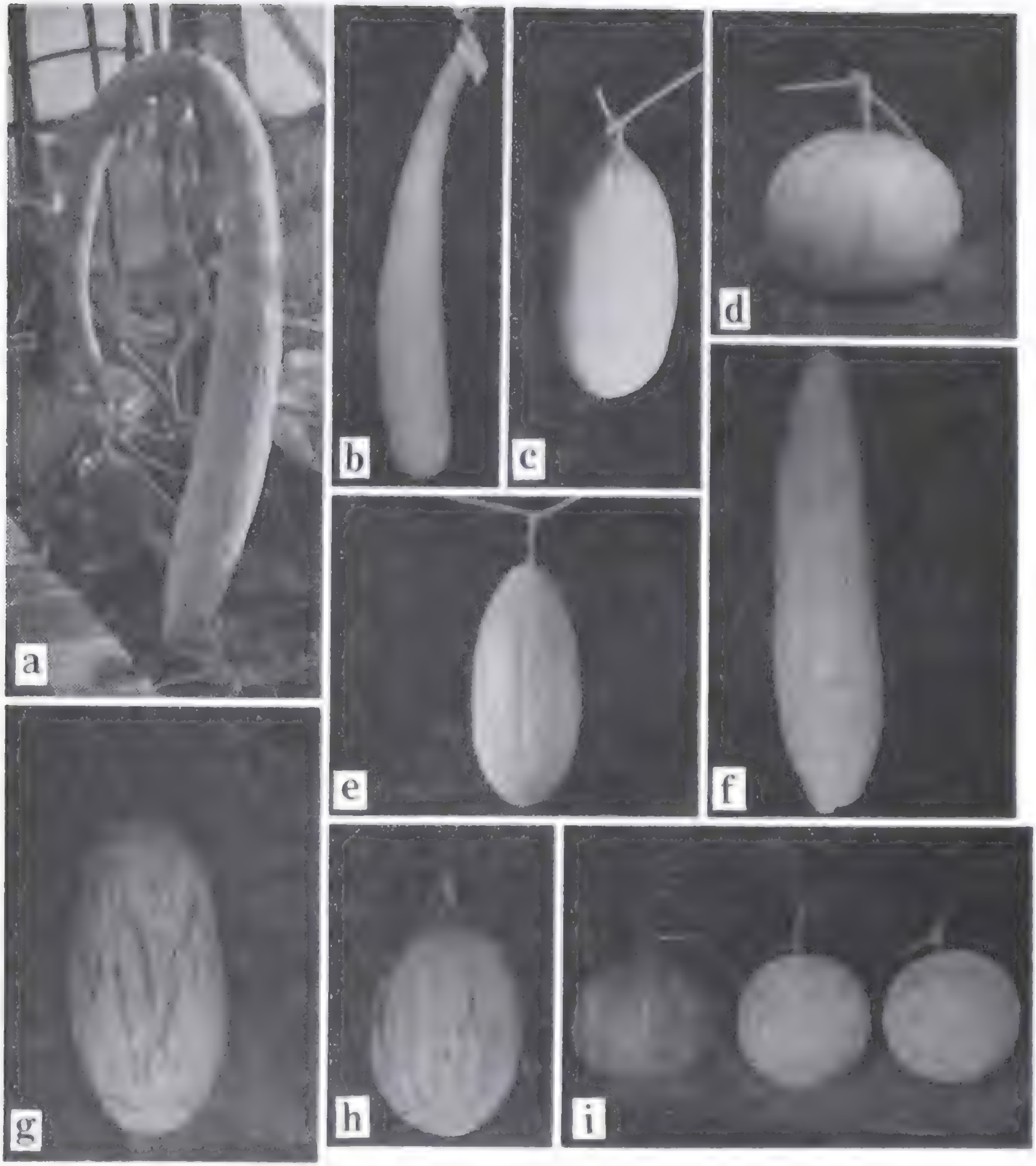


Fig. 7. Representative fruit forms of the KUSE strains and their F_1 hybrids with Earl's Favourite

a, b. Snake melon (var. *flexuosus* NAUD.):
a. No. 111, b. No. 1003.
c∼e. Undescribed miscellaneous varieties:
c. No. 505, d. No. 984, e. No. 981
f∼i. F_1 fruits between the KUSE strains and Earl's Favourite:
f. No. 111 × Earl's Favourite, g. No. 1003 × Earl's Favourite,

Fig. 8. Heavily cracked F_1 fruits of Earl's Favourite × No. 701 at maturity

MUNGER obtained a similar result as in the present investigation. SCOTT and KAJIURA, however, reported that muskmelon did not lose its vigor in growth even when it was inbred and that there was no indication of hybrid vigor.

2. Flower characters:

Corolla of *C. melo* L., either of pistillate or staminate flower, is generally bell-shaped, gamopetalous and five-lobed. The corollas of most of the KUSE strains were larger in size and deeper lobed than those of most of the commercial varieties including Earl's Favourite grown in Japan. F_1 hybrids showed the intermediate corolla types.

Three to five staminate flowers are borne in clusters in the leaf axils except those occupied by the pistillate or perfect flowers. They have three stamens: two having two anthers and the rest one anther. The pistillate (Fig. 10, right) or perfect flower (Fig. 10, left) is borne solitary in the first, rarely second, axil of primary lateral vine (Fig. 9).

The flower of most of the commercial varieties grown in Japan is andromonoecious. During the pollination work in the early summer of 1956, ten of the KUSE strains, including Nos. 111, 981 and 1003, were found to be monoecious. No. 505 showed a segregation in respect to this character. In F_1 hybrids, monoecious was exhibited as dominant. ROSA (1928) reported that in muskmelon,

Table 3. Characteristics of the fruits of F_1 hybrids and their parents (1957)

Item	Earl's Favourite	No. 82 × E. F.	No. 82	No. 111 × E. F.	No. 111
Days from sowing to harvesting	153	142	135	140	131
Days from flowering to harvesting	58	54	46	52	47
Slip at maturity	none	easy	easy	none	none
Crack at maturity	none	none	none	easy	none
Shape	globular	oval	oblong	slender	cylindrical
Diameter (cm)	12.0	11.3	8.6	9.2	6.4
Length (cm)	11.1	17.2	17.3	33.2	85.4
Weight (gr)	852	1063	562	1321	1146
Color of skin	grayish-green	yellowish-green	orange-yellow	yellowish-green	creamy-white
Net	dense	sparse	sparse	none	none
Rib	none	shallow	deep	rather shallow	furrowed
Pubescence at maturity	smooth	heavy	heavy	smooth	smooth
Diameter of blossom scar (mm)	19.8	7.4	8.8	4.5	3.1
Thickness of flesh (cm)	2.8	2.1	1.2	1.7	1.2
Color of flesh (inner)	yellowish-green	pale-green	salmon-pink	salmon-pink	white
Color of cavity and placenta	light-yellow	creamy-white	salmon-pink	salmon-pink	salmon-pink
Soluble solids*					
(inner flesh)	10.3	10.6	5.1	5.3	2.9
(whole flesh)	8.4	8.1	3.9	4.3	2.1
Flavor	musky-weak	musky	squash-like	cucumber-like	cucumber-like
Acid taste at maturity	none	none	none	slight	slight

Table 3. (Continued)

No. 150 × E. F.	No. 150	No. 242 × E. F.	No. 242	No. 701 × E. F.	No. 701
142	136	145	144	138	133
55	47	53	48	50	43
rather easy	easy	none	none	easy	easy
easy	easy	none	none	easy	easy
oval	oblong	globular	flat	globular	flat
10. 5	10. 4	12. 4	12. 0	11. 6	11. 6
12. 8	15. 0	12. 3	9. 7	11. 9	9. 5
777	810	1064	684	812	604
yellowish-green	yellowish-blotchy	creamy-yellow	yellow	creamy-yellow	yellowish-green
sparse	sparse	slight	none	sparse	dense
none	none	none	none	rather-shallow	shallow
heavy	heavy	heavy	smooth	heavy	heavy
13. 6	20. 0	12. 3	28. 0	10. 8	19. 8
2. 0	1. 9	2. 5	2. 0	2. 3	1. 9
green	orange	white	white	pale-green	white
salmon-pink	orange	white	white	white	salmon-pink
11. 8	8. 8	10. 3	10. 2	10. 8	8. 4
10. 7	7. 1	7. 9	8. 4	9. 4	7. 0
musky	squash-like	musky-weak	musky-weak	musky-strong	musky

Table 3. (Continued)

No. 705 × E. F.	No. 705	No. 981 × E. F.	No. 981	No. 1003 × E. F.	No 1003
141	140	138	135	136	133
51	52	51	41	46	43
easy	easy	easy	easy	easy	easy
rather easy	none	easy	easy	easy	none
flat	globular	oblong	oblong	slender	cylindrical
13. 6	12. 1	9. 6	7. 1	10. 4	6. 6
12. 4	12. 0	15. 6	16. 0	18. 9	46. 6
838	875	757	382	1147	775
creamy-yellow	creamy-yellow	creamy-yellow	yellow	yellowish-green	creamy-white
sparse	sparse	sparse	none	none	none
shallow	shallow	shallow	deep	none	furrowed
heavy	heavy	heavy	heavy	heavy	heavy
20. 2	37. 2	5. 1	4. 2	6. 4	2. 0
1. 9	1. 8	1. 8	1. 0	2. 3	1. 2
salmon-pink	salmon-pink	salmon-pink	salmon-pink	white	white
salmon-pink	orange	salmon-pink	salmon-pink	white	salmon-pink
6. 6	7. 2	8. 4	5. 0	7. 1	1. 1
6. 1	6. 6	6. 8	4. 5	5. 8	1. 4
squash-like	squash-like	Makuwa-like	Makuwa-like	musky	cucumber-like
none	none	none	none	slight	slight

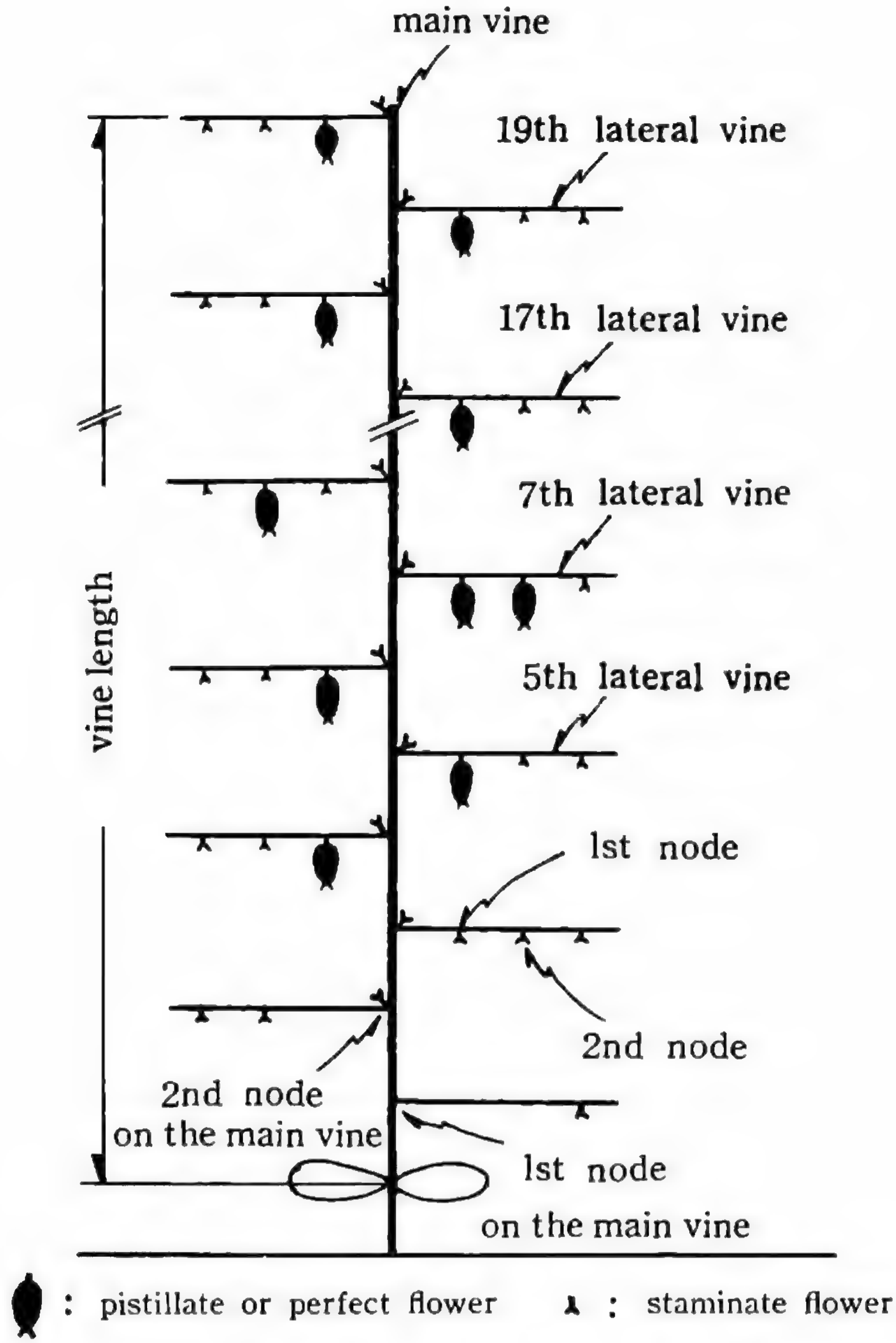


Fig. 9. Diagram of flower bearing habit in melon (*C. melo*): Main vine grown vertically was prunned at the 20th node.

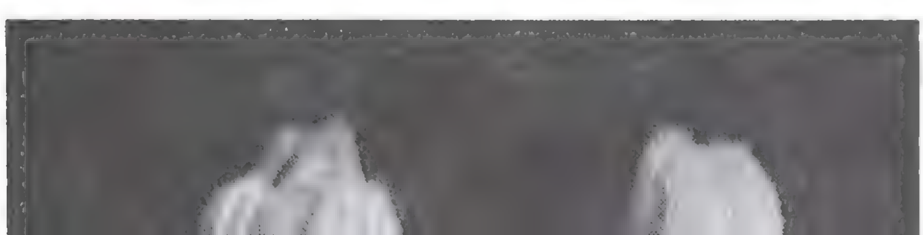


Table 4. Flower bearing habit of the KUSE strains (1956)

Variety or strain No.	Sex expression	Staminate flower on the main vine			Pistillate flower		
		Node No. of 1st flower	Node No. of 1st anthesis	Days to anthesis[a]	Node No.[b]	Days to anthesis[c]	Number of flowers[d]
Earl's Favourite	Andromonoecious	4	4	70	5	79	6
79	Monoecious	3	4	64	8	73	3
82	〃	5	8	56	10	68	6
111	〃	1	1	63	4	70	10
150	Andromonoecious	1	2	60	6	69	7
242	〃	3	5	61	7	71	9
505	Andro. or Mono.	1	1	58	5	68	9
506	Andromonoecious	2	2	60	7	71	9
507	〃	5	5	60	5	71	10
508	〃	1	1	59	7	66	9
701	〃	1	1	57	5	66	10
702	〃	1	1	56	3	73	10
705	〃	2	2	57	6	67	5
707	〃	1	1	59	8	69	6
764	〃	2	3	60	5	71	9
766	〃	2	3	59	7	73	9
770	〃	5	6	—	—	—	—
775	〃	4	5	58	5	66	10
776	〃	2	3	60	6	70	7
980	〃	7	9	60	10	72	5
981	Monoecious	3	3	59	8	67	5
982	〃	4	4	60	7	69	8
983	〃	1	1	61	7	67	8
984	Andromonoecious	7	7	61	13	—	2
985	Monoecious	3	5	63	7	69	7
986	Andromonoecious	2	2	60	5	64	10
987	〃	6	7	64	6	72	10
988	〃	5	7	64	9	62	4
989	〃	5	8	64	8	71	7

Table 5. Flower bearing habit of F_1 plant between the KUSE strains and Earl's Favourite (1957)

Variety or strain No.	Sex expression	Stminate flower on the main vine		Pistillate flower		
		Node No. of 1st flower	Node No. of 1st anthesis	Node No.[a)]	Days to anthesis[b)]	Number of flowers[c)]
Earl's Favourite	Andromonoecious	6.0	9.2	8	95	6.0
82×E. F.	Monoecious	6.4	11.3	8	88	7.1
82	〃	9.7	14.3	13	—	1.4
111×E. F.	〃	3.8	3.[illegible]	6	88	9.2
111	〃	2.2	2.4	3	84	9.4
150×E. F.	Andromonoecious	3.7	5.1	4	87	9.3
150	〃	2.6	4.4	6	89	8.1
242×E. F.	〃	5.0	10.1	6	92	8.4
242	〃	4.9	14.0	8	—	4.5
701×E. F.	〃	3.8	5.4	4	88	10.1
701	〃	3.3	4.7	6	90	9.1
705×E. F.	〃	4.3	7.0	6	90	6.6
705	〃	3.8	5.6	10	88	3.1
981×E. F.	Monoecious	4.2	6.8	7	87	8.5
981	〃	5.3	8.9	14	—	1.6
1003×E. F.	〃	4.4	9.0	7	90	8.2
1003	〃	4.3	10.3	13	92	2.5

a) Node No. of main vine of lowest lateral vine with pistillate flower.
b) From sowing to anthesis on the 1st node of the 10th lateral vine.
c) Number of flowers on the 1st node of the 5∼15th lateral vines.

bearing habits were observed as shown in Tables 4 and 5. In Earl's Favourite, number of pistillate flowers on the first node of the 5∼15th primary lateral vines was on the average about six. 23 of the KUSE strains produced more pistillate flowers than Earl's Favourite in the spring of 1956. In the following spring, five parental strains of eight F_1 hybrids produced less pistillate flowers than the same

Table 6. Characteristics of cotyledon, adult leaf and vine (1956)

Variety or strain No.	Cotyledon[a)]		Adult leaf[b)]		Main vine[c)]
	Length (cm)	Width (cm)	Length (cm)	Width (cm)	Length (cm)
Earl's Favourite	3.7	2.2	19.0	24.0	145
79	5.6	2.8	16.6	20.3	133
82	5.7	2.4	16.8	10.3	145
111	6.2	2.5	19.3	25.3	173
150	5.5	2.5	19.3	24.3	159
242	4.7	2.3	17.0	27.0	133
505	5.1	2.5	20.3	23.6	133
506	5.4	2.6	22.0	24.0	105
507	7.2	3.0	26.0	28.0	—
508	4.9	2.2	17.5	19.0	113
701	6.2	2.8	17.5	20.6	120
702	6.1	2.7	18.0	21.0	140
705	6.4	3.1	17.0	19.5	119
764	5.1	2.5	20.6	27.0	126
766	5.4	2.5	21.0	26.0	110
775	4.9	2.2	20.0	24.0	107
776	6.1	2.7	24.0	25.5	100
980	5.3	2.2	—	—	177
981	3.4	2.0	16.0	19.0	123
982	4.2	2.1	14.7	17.5	130
983	4.1	2.4	19.5	24.0	152
984	4.9	2.4	15.0	22.0	170
985	4.5	2.1	17.0	22.5	168
986	5.5	2.6	20.8	24.5	125
989	5.0	2.3	19.5	22.0	130
990	4.4	2.3	21.0	24.0	148
1003	4.6	1.8	24.0	24.0	182
1005	5.1	2.1	18.5	21.0	150

The seeds of all the KUSE strains were larger than those of any Japanese varieties including Earl's Favourite. The variation of seed coat color was similar to the commercial varieties grown in Japan. INOUE (1935) classified melons by the seed characteristics such as length, color and shape. After INOUE, *C. melo* L. var. *makuwa* MAKINO, which includes varieties cultivated outdoors in Japan and China, has the smallest seed of all the botanical varieties.

Table 7. Fertility and seed characteristics (1956)

Variety or strain No.	Seeds per fruit	Good seeds per fruit	Seed-fertility (%)	Length of seed (mm)	Diameter of seed (mm)	Color of seed
Earl's Favourite	411	292	71. 0	9	4	creamy-brown
79	342	272	79. 5	13	5	〃
82	452	263	58. 3	11	5	creamy-yellow
111	282	205	72. 6	13	5	creamy-white
150	441	224	50. 8	13	6	creamy-yellow
242	386	291	75. 6	12	5	yellow-brown
505	578	435	78. 7	10	5	creamy-yellow
506	328	37	11. 2	15	6	creamy-white
507	402	173	43. 1	14	6	〃
508	337	84	24. 9	12	5	〃
701	361	161	44. 6	14	6	creamy-yellow
702	411	103	25. 0	14	6	creamy-white
705	365	157	42. 9	15	6	〃
707	286	192	67. 1	12	5	〃
764	238	154	64. 7	14	6	creamy-yellow
775	344	121	35. 1	14	6	〃
980	275	229	83. 8	12	5	creamy-white
981	387	302	78. 0	9	4	〃
982	263	172	65. 4	10	4	creamy-brown
983	853	595	69. 7	10	5	creamy-yellow
984	416	293	70. 4	12	5	creamy-white

Table 8. Pollen-fertility of the F_1 and their parental plants, and characters of F_2 seed (1956~1957) * E. F. : Earl's Favourite

Variety or strain No.	Pollen-fertility (%)	Length of seed (mm)	Diameter of seed (mm)	Color of seed
Earl's Favourite	99. 1	9. 0	4. 0	creamy-brown
82 × E. F.*	99. 0	10. 1	4. 8	〃
82	98. 7	10. 0	4. 5	creamy-yellow
111 × E. F.	99. 3	9. 2	4. 6	creamy-white
111	99. 7	11. 6	5. 6	〃
150 × E. F.	99. 0	10. 6	5. 0	〃
150	98. 3	10. 2	5. 1	creamy-yellow
242 × E. F.	98. 7	10. 2	4. 7	creamy-brown
242	97. 5	12. 6	5. 4	〃
701 × E. F.	95. 1	10. 7	4. 9	creamy-yellow
701	92. 1	12. 9	4. 8	〃
705 × E. F.	98. 0	13. 1	5. 8	creamy-white
705	99. 5	14. 2	6. 3	〃
981 × E. F.	99. 3	9. 1	4. 5	〃
981	98. 9	9. 1	3. 7	〃
1003 × E. F.	85. 3	11. 3	5. 0	〃
1003	94. 5	11. 7	4. 8	〃

In 1957, the size of seeds from F_1 plant was found to be more or less intermediate between the parents. LUMSDEN (1914) found that large seeds dominanted over small seeds.

5. Crossing ability :

Pollen-fertility was estimated by percentage of pollen grains stainable with aceto-carmine observed during May on the materials sown in February 13, 1957. The data are given in Table 8. In most of the F_1 hybrids between the KUSE strains and Earl's Favourite, the rate of good pollen was as high as 90 per cent, and a good deal of viable seeds were obtained. The similar was found in the hybrids between the KUSE strains and Japanese commercial varieties belonging

B. Classification

In the genus *Cucumis*, about 35 species were involved according to the latest supplement of the Index Kewensis. Most of them are tendril-climing or trailing annuals or herbaceous perennials. DE CANDOLE (1884) listed 26 species in the genus, of which ufive are native to India and Pakistan, three to north Africa, 16 to central Africa, nine to south Africa, and one to tropical America. VAVILOV (1926) stated that muskmelon is native to Iran and its adjacent areas. He also reported that Iran and Trans-Caucasusia are thought to be the main center of origin and development, and the north-west province of India, Kashimir and Afghanistan to be the secondary center.

Cucumis generally cultivated in Japan is cucumber (*C. sativus*), netted melon (*C. melo* var. *reticulatus*), winter melon (*C. melo* var. *inodorus*), oriental sweet melon (*C. melo* var. *makuwa*) or oriental pickling melon (*C. melo* var. *conomon*).

The taxonomical studies of *C. melo* L. were reported by many workers: NAUDIN (1859), MAKINO (1940), KITAMURA (1957, 1960), INOUE (1935) and BECKER (1950). NAUDIN listed ten botanical varieties, MAKINO four varieties, KITAMURA one variety and BECKER one variety. They are listed in Table 9.

Table 9. The list of botanical varieties of *Cucumis melo* L.

Varieties	English name	Japanese name
C. melo var. *reticulatus* NAUD.	Netted melon	Ami melon
〃 var. *cantaloupensis* NAUD.	Rock melon	—
〃 var. *flexuosus* NAUD.	Snake melon	Hebi melon
〃 var. *inodorus* NAUD.	Winter melon	Fuyu melon
〃 var. *acidulus* NAUD.	Cucumber melon	—
〃 var. *chito* NAUD.	Garden melon	—
〃 var. *dudaim* NAUD.	Pomegranate melon	—
〃 var. *saccharinus* NAUD.	Pineapple melon	—
〃 var. *conomon* MAKINO	Oriental pickling melon	Tsuke-uri or Shiro-uri

Table 10. Classification of the KUSE strains of *Cucumis melo* L

Variety	KUSE strain No.
var. *reticulatus* NAUD.	82, 150, 506, 507, 508, 701, 702, 705, 764, 766, 775, 776, 986, 989.
var. *inodorus* NAUD.	79, 242, 980.
var. *flexuosus* NAUD.	111, 1003, 1005.
Miscellaneous	505, 707, 981, 982, 983, 984, 985, 987, 988, 990.

and ten other miscellaneous strains have not yet been classified. Snake melon (var. *flexuosus*) has hitherto rarely been known in Japan and this is perhaps the first introduction. The classifications are not complete, for hitherto undescribed strains may be produced from free crossing within botanical varieties of *C. melo* L. and the characteristics of fruit vary with the cultivated conditions. Since there are common characteristics among the botanical varieties of *C. melo*, it is rather difficult to give a definite classification based only on the data of morphological analyses.

Conclusion

In general, the KUSE strains from Pakistan, Afghanistan and Iran seem to be not suitable for practical cultivation in Japan, since their fruits are inferior in appearance, sugar content, flesh quality and thickness of flesh as compared with the Japanese commercial varieties. In some strains fruit was easily cracked and shed from the stem at maturity. Moreover, the KUSE strains are generally susceptible to disease and cultivation are rather difficult even in a glasshouse.

However, such characteristics as earliness and pistillate flower formation unaffected by day-length or temperature of No. 701, prolificacy and resistance to virus diseases of No. 111, bearing of unisexual flower in some strains which facilitate commercial F_1 seed production, will be useful as the material for future

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Luffa acutangula ROXB. collected by KUSE, 1955

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In 1955, two strains of a sponge-gourd, Nos. 145 and 1002, were introduced by the members of the Kyoto University Scientific Expedition (KUSE) to the Karakoram and Hindukush in 1955. The seed coat was black and smooth. As they have no wings, they were identified to be *Luffa acutangula* ROXB. (Fig. 1).

a. No. 145 (1956)

b. No. 1002 (1960)

Fig. 1. KUSE strains of sponge-gourds

Table 1. Data of observations

Item		No. 145*	No. 1002	Control
Cotyledon size		8.7 cm × 5.4 cm	6.3 cm × 3.4 cm	5.4 cm × 3.1 cm
Date of 1st flower	1956 ♀	July 10	September 17	July 15
	♂	June 28	August 25	July 14
	1960 ♀		July 27	July 14
	♂		July 19	July 18
Flowering		Evening	Evening	Evening
Stem length	June 25, 1960		13.9 cm	11.0 cm
	July 28, 〃		346.0	387.1
	Sept. 4, 〃		720.0	763.3
	Oct. 3, 〃		806.7	—
Pollen grains	fertile		200	157
	sterile		0	1
	size		83.1 μ	86.8 μ
Fruit	peduncle length		16.0 cm	15.1 cm
	length		30.8	37.0
Fruit diameter	upper part		3.4	3.3
	lower part		8.2	7.0
Weight of sponge fibre per fruit			27.0 gr	22.0 gr
Seed coat color			Black	Black
Seeds per fruit	solid seeds		250.3	145.0
	empty seeds		15.3	8.0

* Diseased by *Fusarium* and died in 1960.

cotyledons, and their flowering dates were also nearly the same with the Japanese varieties.

Since the resistance to *Fusarium* sp. and *Meloidogyne incognita* var. *acrita* is important for breeding purposes, hope was placed on the introduced strains, but the results were rather disappointing. No. 145 was damaged severely by *Fusarium*

Red peppers (*Capsicum annuum* L.) collected in Afghanistan and Iran

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Red peppers (*Capsicum annuum*. L.) are used for food, for pungent flavoring or drug production, and the more pungent they are the more highly are they valued for their pungent substance, capsaicin.

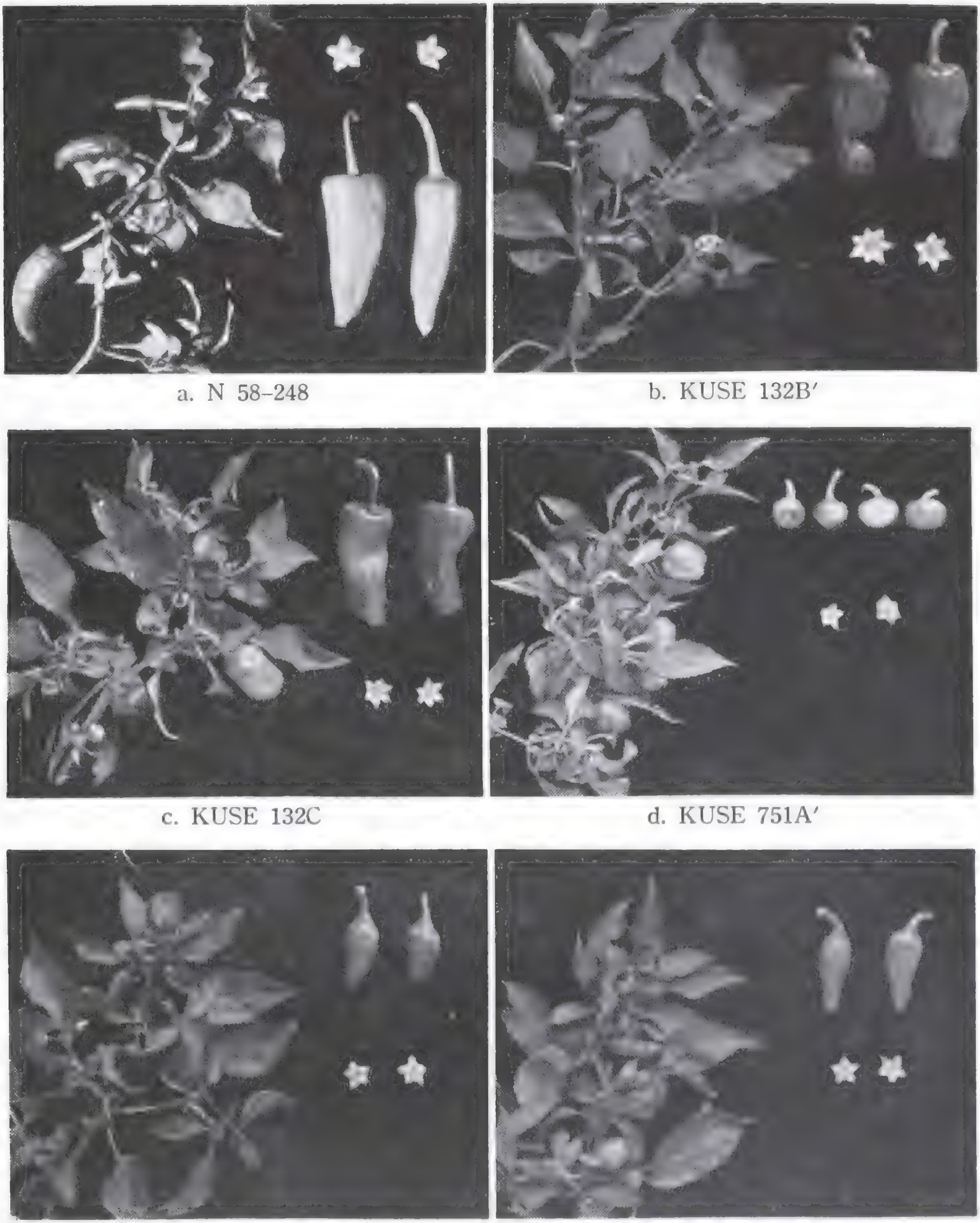
A number of research works have been made with this crop with special emphasis on horticultural studies. And, constructive breedings are pending, that is, introduction of useful characters from related and/or wild species.

Material and Method

In 1955, the members of the Kyoto University Scientific Expedition (KUSE) to the Karakoram and Hindukush collected seeds of four strains of red pepper in Afghanistan and Iran. The seeds were sown in 1956 and the characteristics of the plants were examined in the experiment field of the Kihara Institute for Biological Research in Yokohama (Fig. 1).

Seeds of two strains did not germinate at all, and those of the remaining two (KUSE 132 and 751) germinated. The plants showed wide variation both in morphological and physiological characters. Therefore, they were divided into several pedigree lines according to their characteristics. After repeated self-pollinations, the major characters of each pedigree line became fixed. KUSE 132 was collected in Kabul, Afghanistan, and KUSE 751 in Sabzawar, Iran. N 58-248 collected by Dr. S. NAKAO from Bhutan is also included in the present paper.

The root tips were fixed with FARMER's acetic-alcohol solution after the pre-



a. N 58-248 b. KUSE 132B′

c. KUSE 132C d. KUSE 751A′

e. KUSE 751B′ f. KUSE 751D

Fig. 1. Leaves, flowers and fruits of some introduced strains of *C. annuum* L

and its isomer (Fig. 2). The method is outlined here briefly. 1 g of red pepper powder is treated with 15 ml of acetone on a water bath for about one hour using the reflux condenser. The extract is filtered after cooling and diluted to 25 ml with acetone. 2 ml of the above acetone is removed and the solvent is evaporated on a water bath. The remaining residue is then treated several times with 1 ml of ethanol by which capsaicin is completely absorbed into the ethanol solution. This ethanol fraction is subjected to ascending paper-chromatography at room temperature with petroleum benzine saturated with methanol. In this way purified capsaicin is dissolved into methanol. After the evaporation of the solvent at 70°C the residue is treated with 5 ml of N/10 NaOH solution. When 3 ml of 3% phosphomolybdic acid solution is added, this alkali solution is calculated by BECKMANN's spectrophotomer (Shimazu Type QR-50) at 730 mu in comparison with standard results previously obtained from a pure sample of capsaicin.

For genetical studies of pungency, the following simplified method was employed, because of the wide variation in capsaicin content and of the number of individuals tested. That is, capsaicin was extracted with 3 ml ethanol from a 100 mg sample, ethanol was added to make a 5 ml original solution, of which each 0.5 ml was diluted by adding 2 to 110 ml water. Threshold of taste corresponded to the capsaicin content and volume of added water, *i. e.*, it was 1.3×10^{-6}.

Results and Discussion

1. General characters

The characteristics for 11 pedigree lines and two Japanese common varieties for comparison are given in Tables 1 and 2, and the photographs of some of them and N 58-248 are shown in Fig. 1 (OHTA 1958). All KUSE lines belonged to *Capsicum annuum* L., and in general showed vigorous growth, prolific fruiting and strong pungency. Major mophological characteristics of them were white petals (rarely purple), purplish-blue anthers, white filaments, usually green immature fruit, mature red fruits, yellow seed, and one pedicel at each node.

2. Growth and flowering characters

Growth of the KUSE lines was somewhat more vigorous than that of the

Table 1. Characteristics of plant, stem, leaf and flower of Afghan, Iranian and Japanese red peppers

Material	Plant		Stem	Leaf				Flower				
	Height (cm)	Branching[1]	Color[2]	Shape[3]	Length (mm)	Color[4]	Hair[5]	Date of first flowering	Color of petals[6]	Color of anthers[7]	Number of petals and stamens	Diameter of corolla (mm)
132A	52	CS	4	OL	83	I	SH	17/VI	W	PB	5~6	19
B	60	S	〃	L	112	CD	〃	24/VI	〃	〃	5	14
B′	45	CS	2	LL	75	I	〃	25/VI	〃	〃	5~6	18
C	61	E	3	L	80	〃	〃	5/VI	〃	〃	5~7	15
751A	59	CS	〃	〃	101	CD	〃	17/VI	〃	〃	5~6	13
A′	43	S	2	〃	48	I	〃	4/VI	〃	〃	〃	13
B	60	E	3	LL	95	〃	〃	2/VI	〃	〃	〃	16
B′	77	〃	〃	L	87	〃	〃	〃	〃	〃	〃	13
C	58	〃	5	〃	62	D	〃	〃	V	〃	〃	17
C′	46	CS	〃	OL	75	CD	〃	20/VI	〃	〃	〃	15
D	52	E	3	L	81	I	〃	4/VI	W	〃	〃	12
Takano-tsume	62	CS	1	LL	62	CD	〃	20/VI	〃	〃	〃	14
Ojishi	55	〃	〃	OL	108	I	〃	28/VI	〃	〃	5~7	23

1) CS: Comparatively spreading, S: Spreading, E: Erect. 2) Grades are as in Fig. 3. 3) OL: Ovate lanceo
LL: Long lanceolate. 4) I: Intermediate, CD: Comparatively dark-green, D: Dark-green. 5) SH: Slightly hairy
V: Amethyst-violet. 7) PB: Purplish-blue. 8) P: Pendant, H: Horizontal, E: Erect.

Table 2. Characteristics of fruit of Afghan, Iranian and Japanese red peppers

Material	Fruiting position[1]	Color		Length of pedicel (mm)	Length (mm)	Width (mm)	Shape index	Weight (g)	Thickness of pericarp (10^{-2}mm)	Number of loculi	Shape of calyx[3]
		Immat.[2]	Mat.								
132A	P	DG	Red	26	42	38	1.1	13	27	2~3	NE
B	〃	〃	〃	30	41	29	1.4	8	21	3	〃
B′	〃	〃	〃	26	43	30	1.4	9	19	3~4	〃
C	〃	〃	〃	31	56	19	2.9	6	14	2~3	〃
751A	〃	〃	〃	15	20	27	0.7	6	29	3~4	〃
A′	〃	〃*)	〃	23	14	18	0.7	2	19	〃	〃
B	〃	〃	〃	22	27	21	1.3	4	20	2~3	I
B′	〃	〃	〃	17	30	18	1.7	3	22	〃	〃
C	〃	〃	〃	16	36	18	2.0	5	23	2~4	〃
C′	〃	〃	〃	17	33	22	1.5	6	20	〃	NE
D	〃	〃	〃	21	36	16	2.3	3	16	2~3	I
Takano-tsume	E	〃	〃	24	27	7	3.9	0.4	10	〃	E
Ojishi	P	〃	〃	36	62	54	1.1	45	66	2~4	NE

1) P: Pendant, E: Erect. 2) DG: Dark-green. *) Color changes like a Japanese var. "Goshiki". 3) NE: No
I: Intermediate, E: Embracing. 4) P: Prolific, EP: Extremely prolific, NP: Not prolific.

ing to the area colored and intensity of coloration, namely: 1) no pigment, 2) some pigment around the nodes, 3) more pigment around the nodes, 4) pigment extending to the internodes and 5) whole stem strongly colored (Fig. 3).

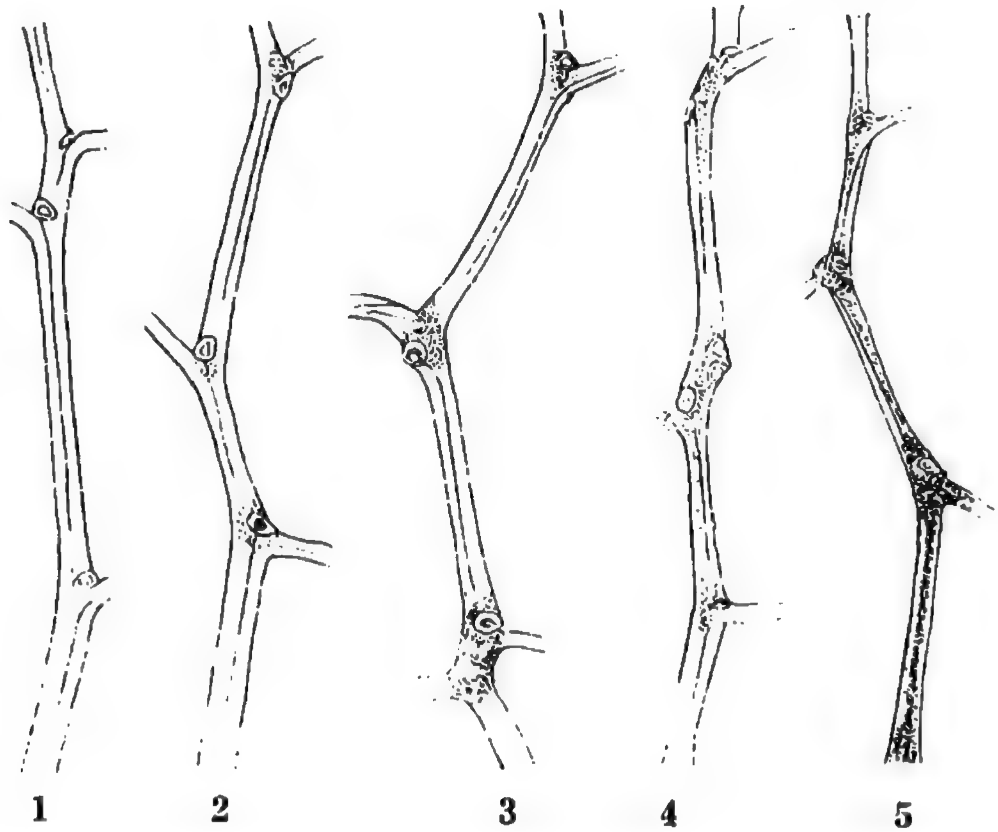


Fig. 3. Schematic representation of five grades of stem pigmentation

The lines 751C and 751C′ had a strikingly violet stem and also an amethyst-violet corolla. This pigment was located on the lower surface of the petals, and became darker when it got colder. This color of corolla was not known among the Japanese varieties.

4. Fruit characters

The shape of the fruits varied from compressed-round (shape index 0.7) to oblong-conical (2.9). The mature fruit color was red in all lines, and the immature fruits were dark-green, except for one line, 751A′, which showed at maturity colors like a Japanese variety "Goshiki".

5. Capsaicin content

The capsaicin content in dry matter of varieties of *C. annuum* is shown in

Table 3. Capsaicin content-dry matter (%)

Material	Average	Comparison between 2x and 4x				Variation under different growing conditions		
			min.	max.	av.	30°C	20°C	Field[1]
Long Red Cayenne	0.55					0.33	—	0.23
Takanotsume	0.28~0.32							
Yatsubusa	0.21~0.30							
KUSE 132 A	0.24							
B	0.26	2x	0.24	0.31	0.28			
B′	0.28	4x	0.20	0.32	0.27			
C	0.30							
KUSE 751 A	0.32		min.	max.				
B	0.34	2x	0.35	0.37	0.36			
B′	0.36	4x	0.33	0.41	0.38			
C	0.35					0.39	0.35	0.31
D	0.33							
N58-248	0.67							

1) Average temp. was 21~24°C and min. temp. was 14~26°C.

analysis of the capsaicin content.

Young plants of *C. annuum*, KUSE 132A and KUSE 751D, were divided into three groups according to the growing conditions: 1) at 30°C const. 2) 20°C const. and 3) field. Each group consisted of at least two plants.

Plants grown at higher temperature were more vigorous than those at lower temperature. The difference was most remarkable in the case of KUSE 751D (Fig. 4). Capsaicin content was considerably higher at 30°C const., and somewhat higher at 20°C const. than in the field (Table 3). The average temperature in the field was 21°~24°C, and the minimum was 14°~26°C. It was supposed, therefore, that the higher night temperature provided by the constant 20°C condition affected a higher capsaicin content.

6. Induced tetraploids

All the species examined were diploid, 2n=24. In the genus *Capsicum*, however, there have been a number of reports regarding natural or induced polyploids. By colchicine treatment, the present author obtained autotetraploids of KUSE 132B′ and KUSE 751B′. In general, tetraploids showed giant stomata, thicker mesophyll, thicker pericarp, and giant flowers in comparison with diploids. Tetraploids showed almost the same vigor in growth but somewhat less fruiting

than diploids. Tetraploid fruits are shorter (shape indices smaller), less in weight and thicker in pericarp than diploid ones (Fig. 5). Tetraploids produce larger (1.12~1.30 times in diameter, 1.05~1.92 times in weight) but very few seed (1/10~2/5) (Table 4). No marked difference was found in capsaicin content between diploid and tetraploids.

Table 4. Comparison of some fruit- and seed- characters between diploids and induced autotetraploids

Material	Ploidy	Fruit						Seed	
		Length	Width	Shape index	Fresh weight (mg)	Dry weight (mg)	Average number of seeds	Diameter (mm)	Weight (mg)
KUSE 132B′	2x	43.3	29.9	1.45	8630	1484	106.0	4.0	6.4
	4x	33.0	28.6	1.15	7260	1220	20.7	4.5	6.7
KUSE 751B′	2x	29.6	17.6	1.68	3320	777	45.3	4.0	6.9
	4x	27.3	17.2	1.59	2855	637	18.4	4.8	9.2

Fertility in both reciprocal crosses between diploids and tetraploids and their artificial self-pollination is listed in Table 5. In general, fruit setting in selfing was lower and germination was less uniform in tetraploids. On the contrary, fruit setting in 2x (♀) × 4x (♂) crosses was markedly lower than that of the female

Table 5. Cross-compatibility between diploids and autotetraploids

Material	Pollination	Number of flowers	Number of fruits	Fruit setting %	Number of seeds per fruit			Germination %
					min.	max.	aver.	
KUSE 132B′	2x selfing	17	5	29	64	115	96.8	86
	2x × 4x	16	1	6	—	—	3.0**	0
	4x × 2x	7	3	43	0*	4	1.7	—

parent, and it was rather higher in 4x (♀) × 2x (♂) than that of the female parent. The data here are quite similar to those of NISHIYAMA and KARASAWA (1954). The number of seeds per fruit was very few in both crosses; a few viable seeds were obtained in 4x × 2x, but only empty seeds in 2x × 4x.

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Beets collected by KUSE, 1955

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Six strains of beet were collected in 1955 by the members of the Kyoto University Scientific Expedition (KUSE) to the Karakoram and Hindukush, they are Nos. 780, 791, 815, 1069, 1070 and 1071. The seeds of these strains were chosen from the cereal seed samples which were sold in the market. They were sown in the experiment field of the Kihara Institute for Biological Research in Yokohama.

It is thought that Mediterranean area is the original place of beet, but, in the Mediterranean region and southern Asia, there is no sugar beet cultivation. There are only table and fodder beets. All of the KUSE beets are fodder beets and biennial. They are weak and very susceptible to *Fusarium*, *Cercospora* etc. It is supposed that because of the dry weather of the place in which they were growing, they became very susceptible to diseases and when they grow in humid place such as Japan, they are completely damaged. Seed number in a seed ball and germination rate are observed (Table 1). There is a slight difference in a seed number of one seed ball. It is not clear whether it is by environment or genetical difference. All strains except No. 1070 have the anthocyanin pigment in the leaves and roots. Root shapes are very similar in all six strains and they are rather long.

Table 1. Characteristics of KUSE beets

Strain	Seed-number in 100 seed-balls	Germination rate	Red pigment*
No. 780	204	24%	+
No. 791	200	16	+
No. 815	164	55	+
No. 1069	146	40	+

Onions and leeks from Afghanistan and Iran

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The present author was responsible for the experiments on the genus *Allium* collected by the Kyoto University Scientific Expedition (KUSE) to the Karakoram and Hindukush in 1955. The seeds of 18 strains were sown but the seeds of eight strains did not germinate. Among ten germinated strains, seven were onions and three were leeks. The characters of the reared plants were investigated in the experiment field for temperature sensitivity in bulbing under various artificial conditions.

Material and Method

The materials are given in Table 1. Awaji Kodaka, a Japanese variety bred from Yellow Danvers Flat, Bombay Large introduced from India and Sweet Spanish introduced from U. S. A. were used as the controls. The soil of Kurume Horticultural Research Station in Fukuoka was clayey and of medium fertility. The seeds were sown on Oct. 10, 1956. Usually the sowing season for onion in Kurume is around Sept. 20. The seedlings of the strain collected in Nomal were sent from the University of Osaka Prefecture in Sakai and planted in Kurume in December. The seedlings were small, but nearly all of them bolted. Following this the sowing time was made later in the present experiments. On Dec. 15, the seedlings of both onion and leek were transplanted at an interval of 10 cm in four rows on a 120 cm wide flat bed. Leek seedlings were transplanted again at an interval of 10 cm in rows of 70 cm distance after the harvest of onions, on June 29 in the following year. Fertilizers were applied as usual.

The KUSE strains of onion showed a significant susceptibility to downy

Table 1. List of materials

Locality		Collection No.	Species
Kabul,	Afghanistan	89	*Allium Cepa* L.
〃	〃	130	*A. porrum* L.
〃	〃	134	*A. Cepa* L.
Kandahar,	〃	1079	〃
〃	〃	1080	—[2]
〃	〃	1081	〃
〃	〃	1082	〃
Nomal,	〃	1075	〃
〃	〃	1076	〃
〃	〃	1077	*A. porrum* L.
〃	〃	1078	—[2]
〃	〃	1212	*A. Cepa* L.
〃	〃	Nomal[1]	〃
Tehran,	Iran	790	〃
〃	〃	800	—[2]
〃	〃	820	*A. porrum* L.
〃	〃	832	*A. Cepa* L.
〃	〃	953	—[2]

1) As the collection No. was not given, the material was named as Nomal.
2) Not germinated.

Table 2. Climatic conditions during the period of experiments

	Nov.	Dec.	Jan.	Feb.	March	April	May	June
Temperature (°C)	10. 9	6. 6	5. 4	3. 9	7. 7	14. 0	17. 6	21. 4
Precipitation (mm)	18. 5	44. 0	72. 5	61. 5	24. 2	356. 1	124. 9	234. 6
Rainy days	3	3	5	7	6	13	14	9
Fine days	13	11	13	7	12	12	11	6

Results

1. Onions (*Allium Cepa* L.)

Damage by cold in winter was little and the growth until March was good, but after April the introduced strains were violently attacked by downy mildew and their growth was retarded.

a) Leaf color: As shown in Table 3, all plants of the strains Nos. 89 and 134 had dark-green leaves, but in the strains, Nos. 1212 and 1079 and Nomal, some plants had dark-green leaves, while others had medium-green leaves. All the plants of No. 790 and most of No. 832 had light-green leaves without bloom. The bulbs of the plants with light-green leaves were all white. In Bombay Large there were two types of leaf color, dark-green and light-green.

b) Leaf shape: The plants of the introduced strains with dark-green leaves had short and narrow leaves with half-round cross-section. The light-green leaf was short and wide, and its cross-section was nearly round (Fig. 1, Table 3). The leaf blades of most of the introduced strains stood at angles of 70~80°. As the branching points at sheath were close to each other, the phyllotaxis of leaves was not regular 1/2, but was apt to become irregular. The phyllotaxis of leaves of Awaji Kodaka and Sweet Spanish, however, was regular 1/2 (Fig. 2). The light-green leaves of the strains, Nos. 790 and 832, were soft and broke easily. In general, the leaf shape of the introduced strains was like that of Bombay Large, even in size.

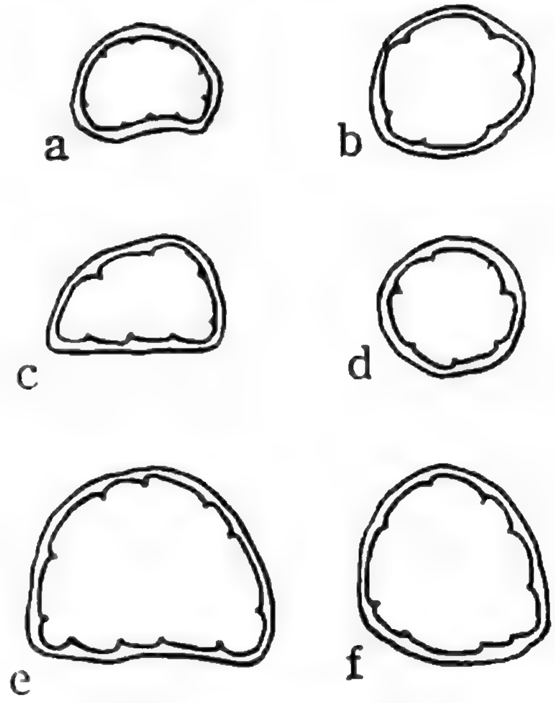


Fig. 1. Cross-sections of leaves of respective varieties and KUSE strains

a. No. 134, b. No. 179, c. No. 1079, d. No. 832, e. Awaji Kodaka, f. Sweet Spanish

Table 3. Leaf characters of *Allium Cepa*

Material	Number of plants	Color			Number of leaves	Cross-section of leaf	Shape of le
		dark-green	inter-mediate	light-green*			
No. 89	11	11			8~9	half-round	slender
No. 134	47	47			8~9	〃	〃
No. 790	13			13	7	round	thick & short
No. 832	15	4		11	6~9	round or half-round	slender or thick &
No. 1212	13	8	5		8~9	half-round	medium
No. 1079	16	12	4		9	〃	slender
Nomal	29	15	14		7~8	〃	〃
Bombay Large	87	62	25		7~8	〃	short
Awaji Kodaka	30	30			9~11	〃	long & large
Sweet Spanish	10			10	8~10	round	〃

* =malachite-green.

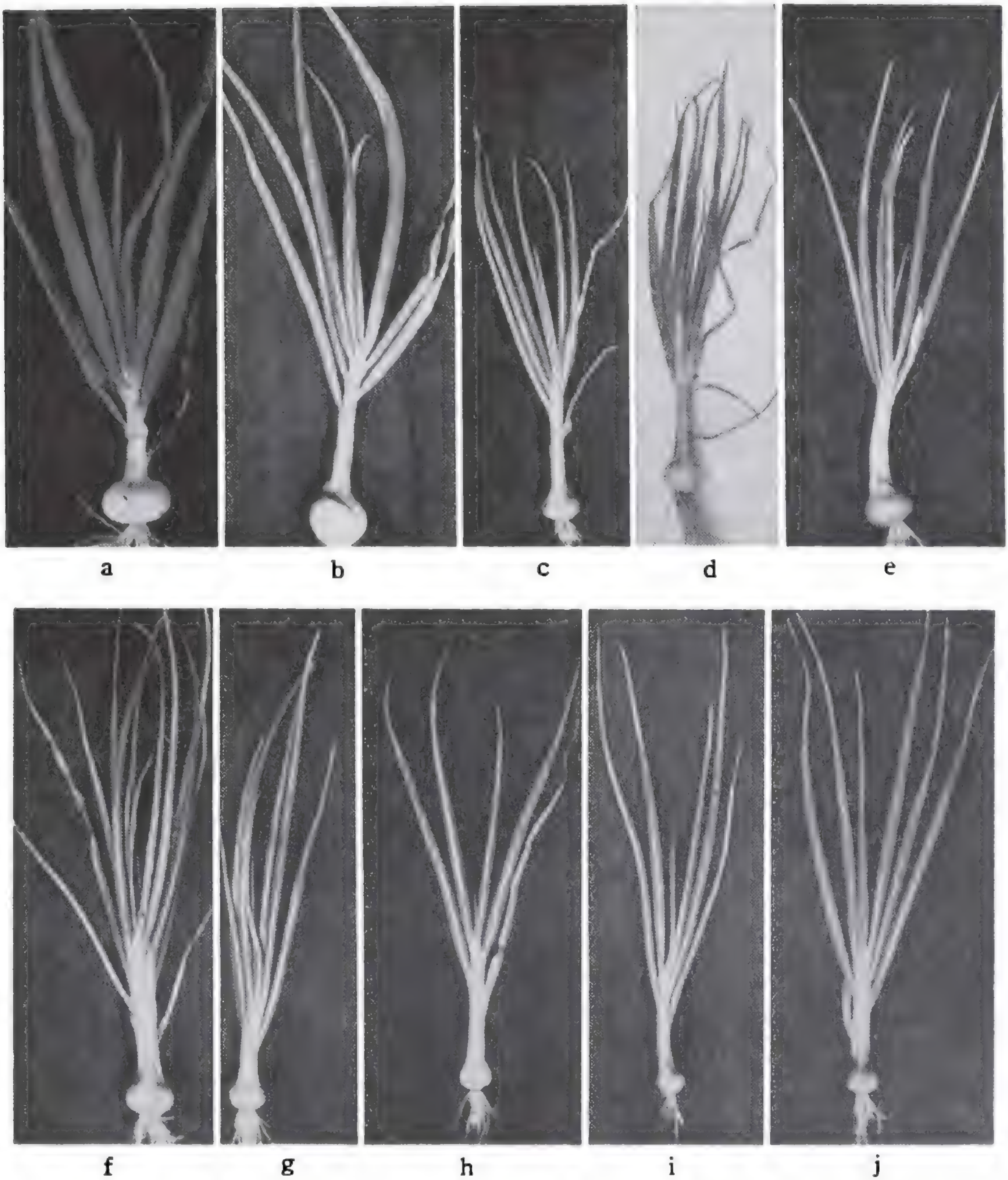


Fig. 2. Plant types of respective varieties and KUSE strains of onions at the bulbing time

a. Awaji Kodaka, b. Sweet Spanish, c. Bombay Large, d. Nomal, e. No. 1212, f. No. 1079, g. No. 832, h. No. 790, i. No. 134, j. No. 89

Table 4. Bulb characters of *Allium Cepa*

Material	Bulb color	Number of plants	Weight (gr)	Diameter (cm)	Height (cm)	Shape index*	Pungency
No. 89	purplish-red	4	39	4.6	2.8	0.61	medium~strong
	yellow with red neck	4	30	3.3	2.8	0.86	
	brown	1					
	white	2	21	3.8	2.6	0.67	
No. 134	purplish-red	25	65	5.8	3.0	0.52	medium~strong
	yellow with red neck	12	55	5.4	3.0	0.50	
	brown	4					
	white	6	33	4.5	2.8	0.62	
No. 790	white	13	32	4.1	2.7	0.67	very mild~mild
No. 832	purplish-red	2					
	yellow with red neck	2	12	2.5	1.7	0.68	
	white	11	18	3.5	2.4	0.68	medium~strong
No. 1212	purplish-red	3	30	4.3	2.5	0.58	medium~strong
	yellow with red neck	7	34	4.5	3.3	0.73	〃
	brown	2					
	white	1					
No. 1079	purplish-red	14	31	4.4	2.7	0.62	strong~very strong
	yellow with red neck	2	33	4.6	2.6	0.57	〃
Nomal	purplish-red	18	47	4.7	3.2	0.68	mild
	yellow with red neck	11					

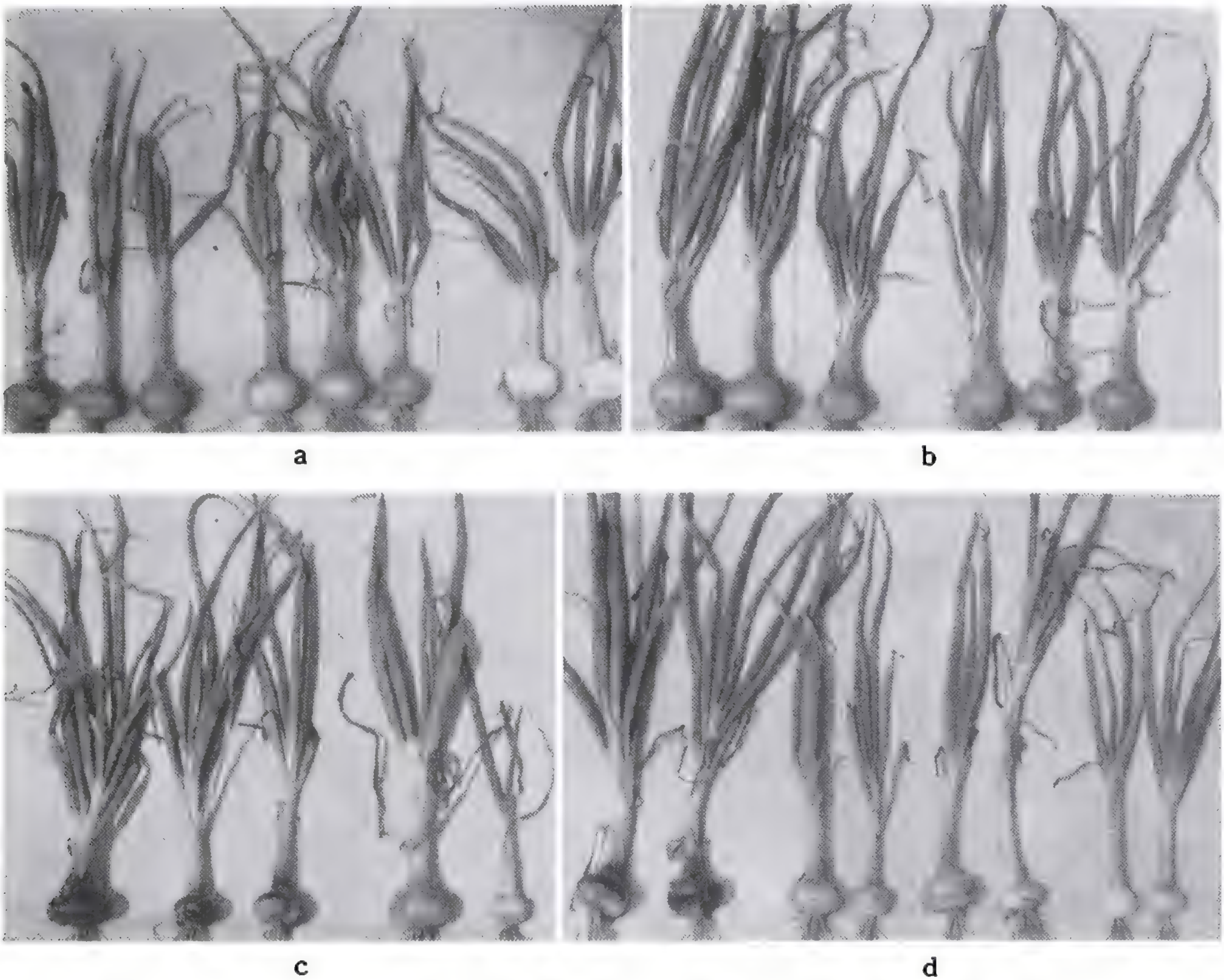


Fig. 3–1. Plant forms of respective varieties and KUSE strains of onions at harvest time
a. Bombay Large b. Nomal c. No. 1079 d. No. 134

the scale color varied in continuation to cream.

However, the number of plants were not large enough to give a definite ratio of segregation, but in general purplish-red and yellow with red neck were more frequent than others. The plants with light-green leaves produced white bulbs, while the plants with either dark-green or medium-green leaves produced the colored bulbs. But 10∼20% of the plants with dark-green leaves produced white bulbs.

f) Size of bulb: As shown in Table 4, a bulb of the introduced strains was

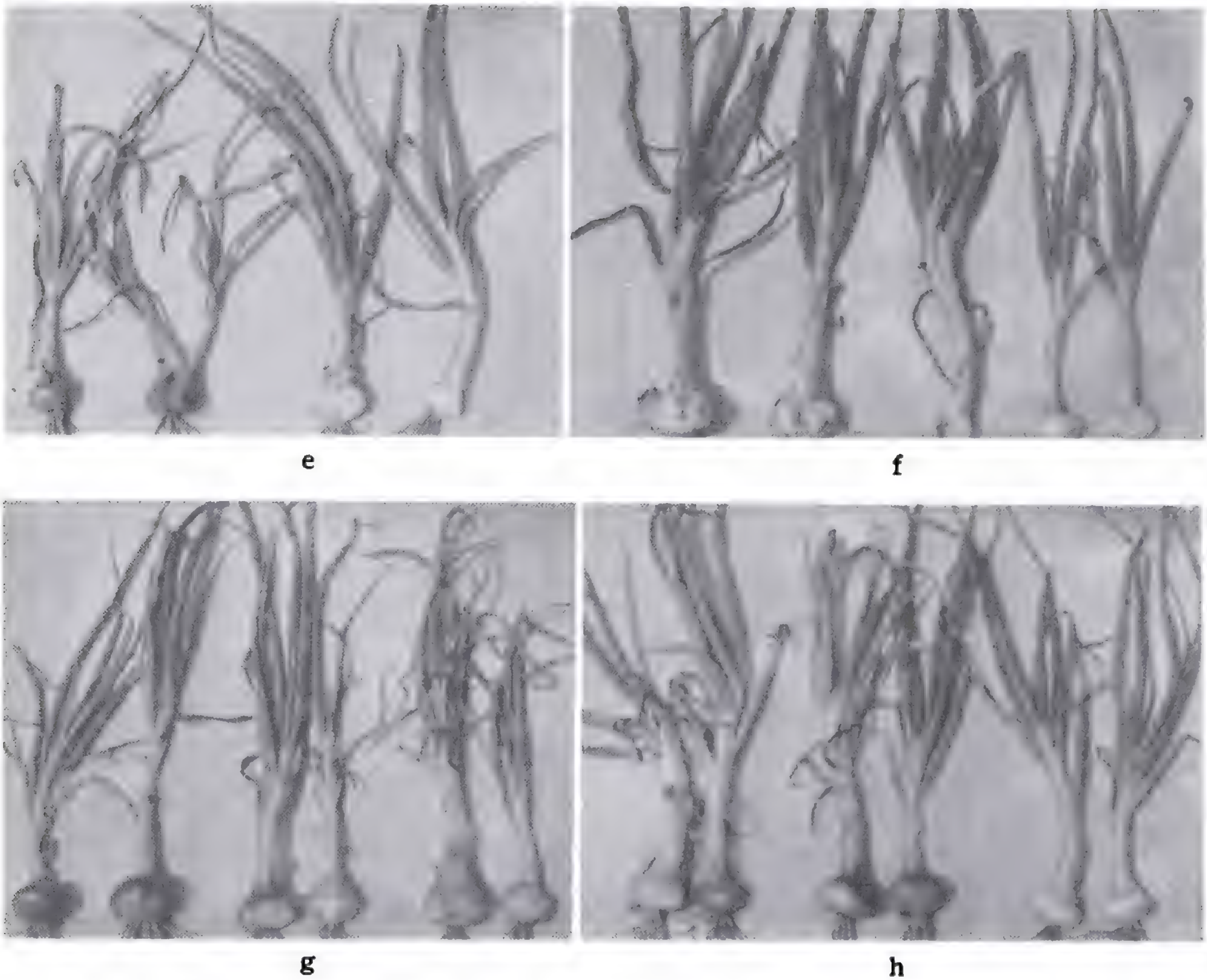


Fig. 3–2. Plant forms of respective varieties and KUSE strains of onions at harvest time

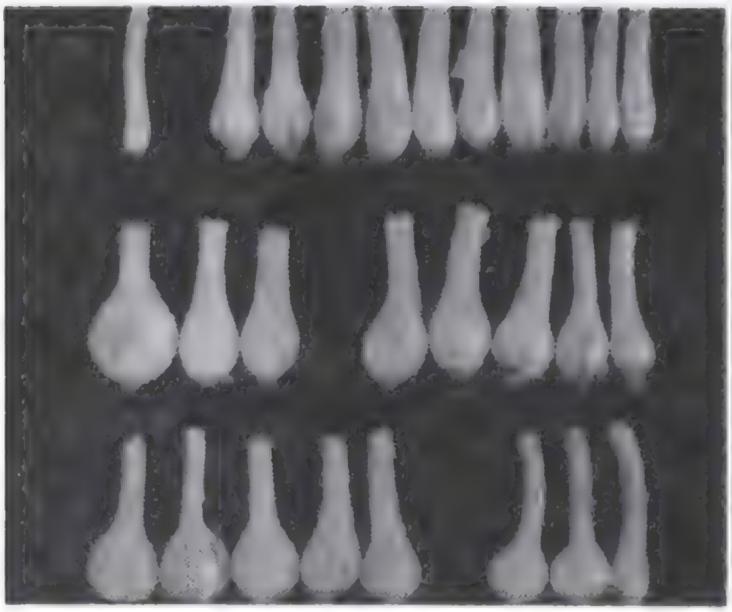
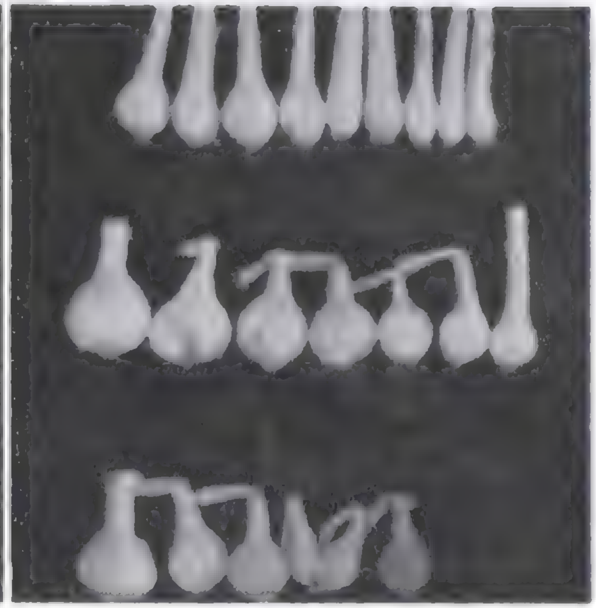
e. No. 832 f. No. 790 g. No. 1212 h. No. 89

g) Shape of bulb: The shape of bulb was expressed by the shape index from the quotient of the bulb height divided by the bulb diameter. As seen in Table 4, the shape index of No. 134 was low and that of No. 89 comparatively high, but others showed the shape index around 1.7, which was not different very much from that of Bombay Large or Awaji Kodaka. The bulbs of the shape index 0.7 were oblate or thick flat (Fig. 3). But the well rounded shoulder part was not very substantial compared with the bulbs of Japanese improved strains.

Table 5. Response of *Allium Cepa* to soil temperature in bulbing

Material	Temperature (°C)	Number of individuals	Degree of bulbing			Number of bolted plants
			None	Imperfect	Normal	
No. 832	15	8	8			0
	20	9	8	1		0
	25	10	3	5	2	0
No. 134	15	8	8			7
	20	6		2	4	4
	25	6			6	5
Nomal	15	9	8	1		7
	20	10		3	7	3
	25	10		2	8	0
Bombay Large	15	8			8	2
	20	10			10	1
	25	10			10	0
Awaji Kodaka	15	9	4		2	0
	20	9	1	3	6	0
	25	7		2	7	0
Sweet Spanish	15	8	5	3		9
	20	10	1	4	5	5
	25	9		2	7	3

j) Temperature reshonse in bulbing: As shown in Table 5 and Fig. 4, Bombay Large bulbed at all treatments but other strains or varieties gave some individuals which did not bulb. The lower the ground temperature was greater was the number of non-bulbing individuals. No. 832 bulbed most poorly, even at 25°C. This strain gave quite a lot of plants which did not bulb, while all or almost all other introduced strains and control strains bulbed at 25°C. No. 134

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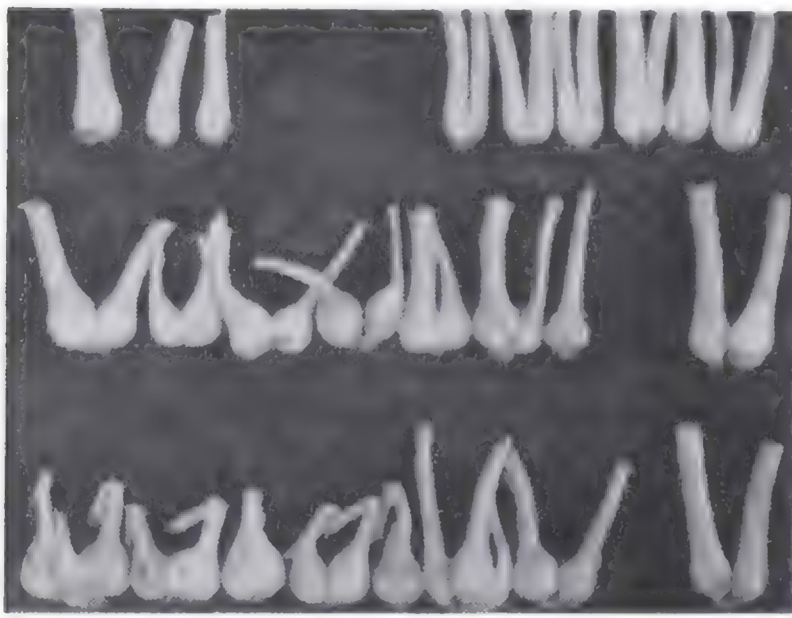


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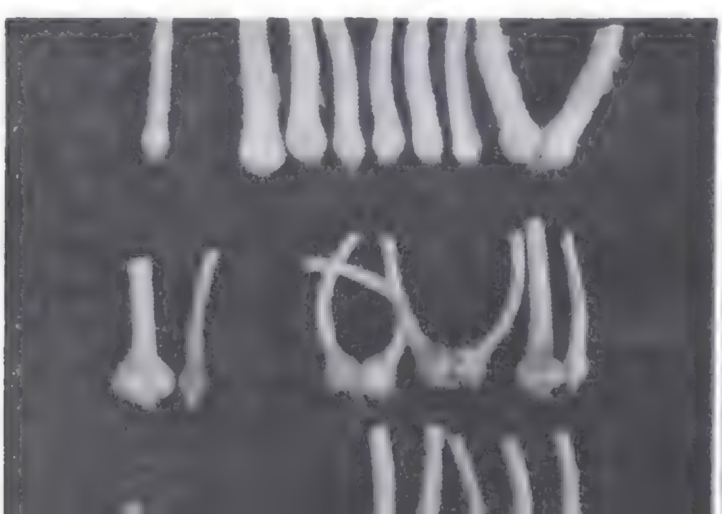


quently the bolting was generally poor. But in the experiment on the response to temperature in bulbing, differences were found between varieties and strains to some extent. (Table 5). Sweet Spanish of a spring type and No. 134 bolted well. It was general that the lower the ground temperature was, the better was the bolting. Awaji Kodaka and No. 832 did not bolt. Bombay Large bolted poorly.

The keeping quality of bulbs in the introduced strains was poor. During the cultivation some of them began to decay, and all the stored bulbs went rotten during July～August. The bulbs from the experiment on temperature response in bulbing were harvested on April 2 and stored. In this case, the percentage of rotted bulbs in three introduced strains was 80～100% before the end of September, but it was 10～30% in Awaji Kodaka and in Bombay Large.

2. Leeks (***Allium porrum* L.**)

Three strains, No. 130 from Kabul, No. 820 from Tehran and No. 1077 from Nomal were leeks. Leek is cultivated usually in Japan as a spring sown crop. But in the present experiment the seeds were sown at the same time as onion in autumn. Therefore the harvest was delayed until Dec. 1. in the following year.

Those leeks had very high resistance to cold, their growth was good, and almost no diseases were observed.

The color of leaves was dark-green, but that of No. 820 was a little darker. The leaves of Nos. 130 and 1077 were narrow and short and the growth was not good, while those of No. 820 were very thick and long, and the growth was vigorous. The results of the harvest on Dec. 1 in the following year are shown in Table 6. The leaf sheath of No. 820 was exceptionally thick.

In the strain No. 820, fourty-three out of 139 plants bolted, but in the strain No. 130, only two bolted among 71 individuals.

Table 6. Leaf characters of the strains of *Allium porrum*

Material	Length (cm)	Breadth (cm)	Number of leaves	Leaf sheath length (cm)	Diameter of sheath (cm)
130	46	5. 0	7–8	15. 8	3. 2
820	61	6. 3	8–9	17. 6	4. 2

was thought to be Baluchistan. VAVILOV (1935) suggested North West India, Afghanistan, Tajik, Uzbek and Shan, West-Iran, as the primary centre of its origin, and Asia Minor, Transcaucasia, Near East including Iran and the Alpine Turkmen, and the coastal area of Mediterranean Sea as the secondary center of its origin.

Among seven strains used in the present investigations five strains were collected in Afghanistan in the primary center after VAVILOV, namely Nos. 89 and 134 from Kabul, No. 1079 from Kandahar, No. 1212 and another one from Nomal, and two strains, Nos. 790 and 832, were collected in Tehran in the secondary center after VAVILOV.

The introduced strains seemed to be indigenous to those habitat countries. They have a smaller number of smaller leaves and smaller bulbs than the garden varieties improved in Europe and America. From the morphological point of view the introduced strains could be said to be primitive ones.

Many of the individuals of the Afghan strains had dark-green leaves with half-round cross-sections. Wide variations in bulb color were observed but many of them were purplish-red. No. 790 from Tehran had light-green leaves with round cross-section, and the bulbs of them were white. Almost all plants of No. 832 had the same leaf characters as No. 790.

The variations in bulb color would have been caused by the mixing of seeds or natural hybridization. There is another possibility that the variation in bulb color would have been maintained since the primitive age without selection. Among the introduced strains the bulbs of yellow with red neck were found in great numbers. This bulb color is not seen among the garden varieties of today, and therefore this may be a primitive character. The bulb of Bombay Large from India was a little big, but the variation in bulb color in this variety was conspicuous, including yellow with red neck, as in the case of some of the introduced strains. Two strains from Tehran, Nos. 790 and 832, had the leaves different from the strains from Afghanistan.

The pungency of bulbs of the Iranian strains, Nos. 790 and 832, was mild. Though the origin of this mild onion is not known, the cultivation of the mild onion was popular. It is also interesting that the two strains of mild onion from Iran had rather peculiar characteristics, namely, light- or malachite-green bloomless leaf with round cross-section. Those characters are found commonly in Sweet

varieties completed bulbing and started the dormancy period in June, many plants of the introduced strains still continued to grow and did not complete bulbing.

The bolting characters were not investigated thoroughly, but No. 832 did not bolt while No. 134 from Kabul and Nomal bolted fairly well. It is known that since the continuation of low temperature around 10°C is required for bolting, autumn sowing is favorable. It is not well explained however why No. 134 collected from Kabul, where the monthly average temperature does not differ from that of Kurume, Japan during the period of onion cultivation, bolted so well.

Those introduced strains, which bolted and doubled easily, were supposed to have been left without adequate selection for a long period. It could be said that most of the introduced strains are primitive, and they will not be useful for practical growing in Japan at present. From a breeding standpoint, they are not very useful because not a single plant of those strains had disease resistance.

Two strains of leek, No. 130 and 1077, from Afghanistan had thin leaves. The strain No. 820 from Iran with especially thick and long sheath grew vigorously but it is not evident if this strain is related to any of the imported garden varieties.

Summary

1. The seeds of 18 strains of *Allium* collected in Kabul, Kandahar and Nomal, Afghanistan and in Tehran, Iran, were sown. Among the ten germinated strains, seven strains were *Allium Cepa* L. and three strains were *A. porrum* L.

2. The leaves of seven strains of onion were erect and small, many in number, and the bulbs were flat round and very small. Five strains from Afghanistan, segregated in bulb color.

3. The introduced strains of onion were generally late growing. They required 25°C or higher temperatures for bulbing. They bolted and also doubled bulbs easily, and were susceptible to downy mildew and other diseases.

4. The strains of onion from Afghanistan had dark-green leaves with half-round cross-section and strong pungency in bulb. The strains from Iran had bloomless light-green leaves with round cross-section and mild pungency in bulb.

Table 7. Temperature and precipitation in Tehran, Kabul and Kurume

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov
Temperature (°C):											
Tehran, Iran	0.7	5.7	8.9	16.3	21.8	26.7	29.4	28.4	25.4	18.8	10.
Kabul, Afghanistan	0.7	2.1	8.2	14.9	20.2	22.9	24.8	24.2	20.4	14.6	10.
Kurume, Japan	4.6	5.2	8.7	13.9	18.3	22.3	26.2	26.9	23.1	17.2	11.
Precipitation (mm):											
Tehran, Iran	41	45	32	26	19	5	2	1	1	4	28
Kabul, Afghanistan	31	36	103	93	20	5	3	4	1	14	21
Kurume, Japan	51	17	118	167	155	306	288	162	210	104	67

F.N. Latitudes: Tehran 35°41′N, Kabul 34°30′N and Kurume 33°20′N.

Althaea, *Abelmoschus* and *Malva* from Pakistan, Afghanistan and Iran

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The following materials have been placed at my disposal from the collections of the Kyoto University Scientific Expedition (KUSE) in 1955. They are listed in Table 1.

Table 1. Materials

Culture No.	KUSE collection No.	Locality	
514	7–30	Tabriz,	Iran
1030	KT 6–6	Kandahar,	Afghanistan
1031	KT 7–20	Kabul,	〃
1130	N 55	Gilgit,	Pakistan
1180	N 115	Minapin,	〃
1184	N 119	〃	〃
1187	N 112	〃	〃
1204	N 147	Hunza,	〃

Althaea rosea

No. 514: Five seeds seemed to be *Althaea rosea*, but they did not germinate.

long ribbed pods (Fig 2). The chromosome number was 2n=124.

The other chracteristics are given in Tables 2 and 3.

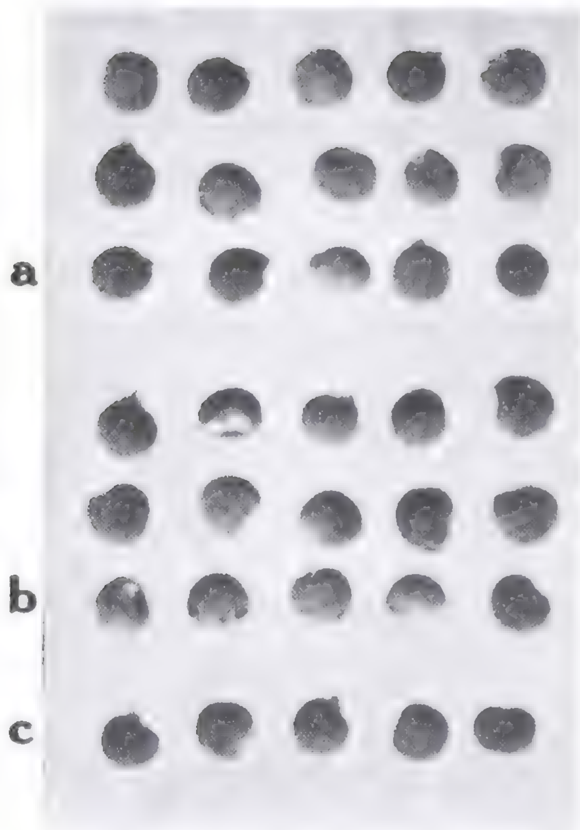


Fig. 1. Seeds of a. No. 1030 (top 3 rows), b. No. 1031 (middle 3 rows), c. No. 1130 (bottom 1 row) ×ca 1.3

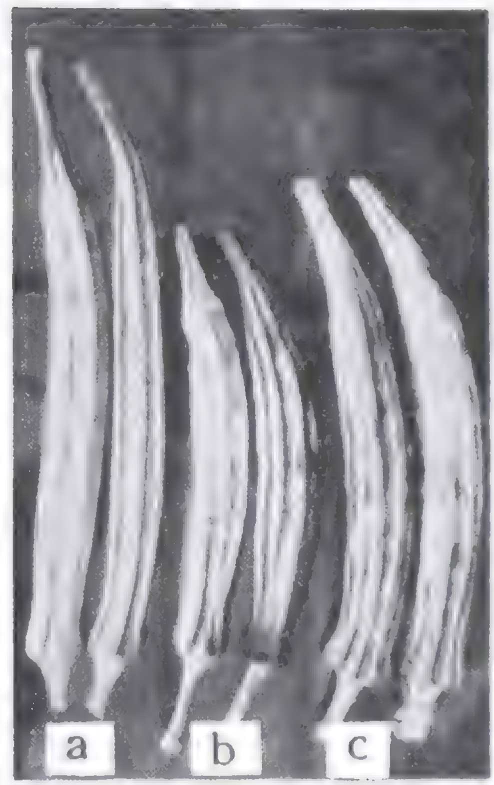


Fig. 2. Pods of *Abelmoschus esculentus* a. No. 1030, b. No. 1031, c. No. 1130 ×ca 1/1.7

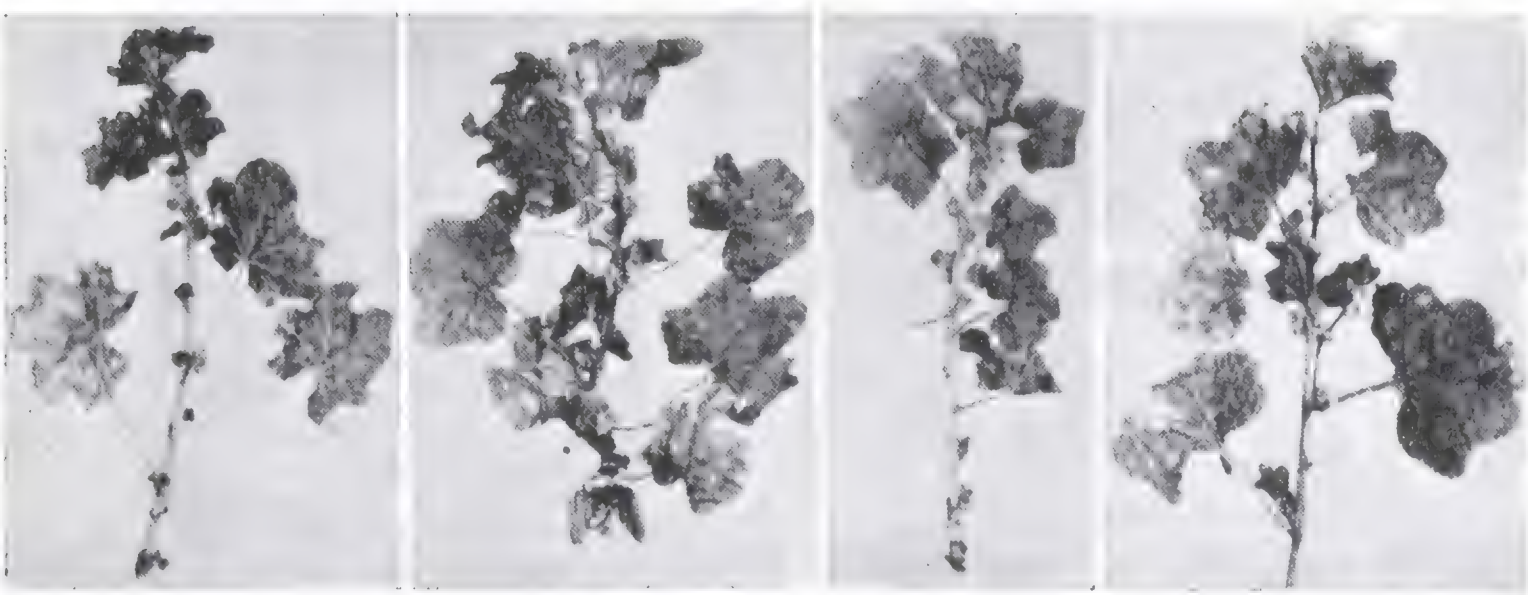
Table 2. Characteristics of seeds and pods

Culture No.	Pod length (cm)	Number of seeds per pod	Seed length (cm)	Seed width (cm)	Seed thickness (cm)
1030	21.2	99.0	4.9 ± 0.2	4.6 ± 0.2	4.3 ± 0.2
1031	14.3	85.0	5.1 ± 0.2	4.5 ± 0.3	4.2 ± 0.3
1130	17.9	106.5	4.8 ± 0.1	4.2 ± 0.2	3.9 ± 0.1

Table 3. Plant characteristics

Malva verticillata

Nos. 1180, 1184, 1187 and 1204: The seeds of germinated well and the plants were all annual herbs (Fig. 3). Stems were nearly glabrous; leaf margin curled or puckered; inconspicuous whitish small flowers clustered sessile; the chromosome number was 2n=84. The other characteristics are given in Tables 4 and 5.



a b c d

Fig. 3. Dried samples of: a. No. 1180, b. No. 1184, c. No. 1187, d. No. 1204

Table 4. Sizes of seed (mm)

Culture No.	Length	Width	Thickness
1180	2. 3	1. 5.	2. 1
1184	2. 4	1. 5	2. 2
1187	2. 4	1. 7	2. 2
1204	2. 4	1. 4	2. 2

Table 5. Plant characteristics

Stoneless pomegranates from Pakistan and Afghanistan[1)]

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The stoneless pomegranate is not a new breed. The material was collected in Pakistan and Afghanistan by the Kyoto University Scientific Expedition to the Karakoram and Hindukush, 1955 (YAMASHITA 1955). As it is little known in the literature of horticulture, I would like to describe the anatomy of the stoneless seeds. It might have arisen as a bud sport in Afghanistan or Pakistan. Since we eat the developed outer integument of the pomegranate seed, botanically the name seedless can not be applied.

For the anatomal examination Afghan material was used. From a careful examination we found that the ripe seeds of the "stoneless pomegranate" contain embryos and endosperms, which are enclosed in two layers representing the inner and outer integuments of the ovule. The embryo does not develop to normal size, though it is not malformed. An endosperm is formed, but remains without cell walls. In normal seeds the outer layer is lignified and the seed is a stone containing an embryo. In the stoneless pomegranate only the outer layer near the embryo is lignified (Fig. 1).

Anatomical differences in the development following pollination between the normal and the stoneless pomegranate are shown in Table 1 (SUTÔ 1958). This table shows that the main difference between seedless and normal pomegranates is the absence or presence of lignification of the outer integument.

Both stoneless and normal pomegranates of Pakistan have 16 chromosomes in somatic cells as already counted by YASUI (1936). However we have not yet examined the chromosomes of the Afghan variety. Pollen-sterility of the stoneless pomegranate was observed in flowers fixed in Pakistan and Afghanistan. In the Afghan variety it was high at 97 per cent. The number of stoneless seeds per fruit was about half of that of the normal variety; the size of the fruit was

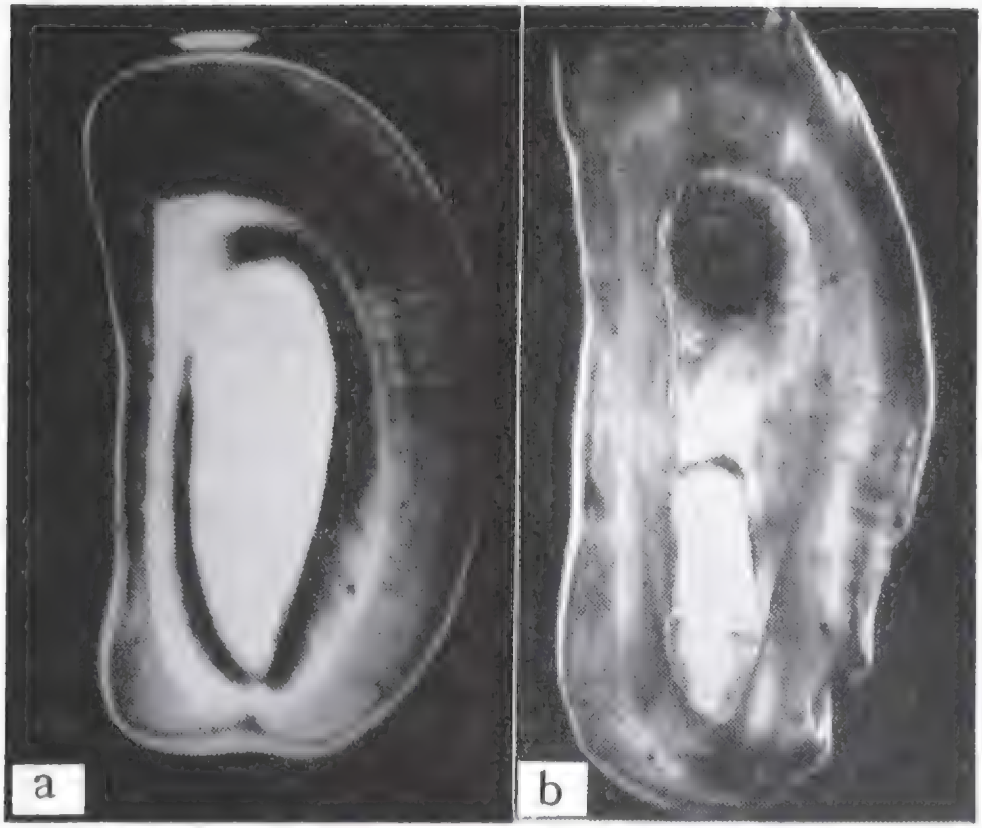

Fig. 1. Longitudinal sections of pomegranate seeds
a. Normal: white area at the center is occupied by the embryo. Strongly stained tissue (black) around the embryo is the lignified outer integument. There is no lignification at the chalazal end. b. Stoneless: a small embryo is present. No lignified outer integument. Endosperm is not absorbed. Free nuclei are visible. Round black spot is the debris of antipodal cells

Table 1. Anatomy of mature seeds in normal and stoneless pomegranates

	Normal	Seedless
Embryo	Embryo develops well and occupies whole embryo sac.	Embryo always present but its development is retarded.
Endosperm	Endosperm is invisible (already absorbed).	Free nuclei are visible.
Tegmen	Almost invisible.	Same as normal.

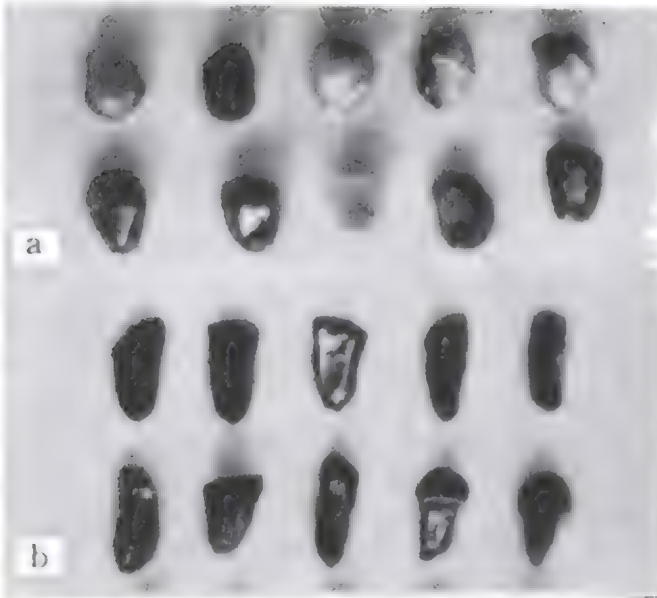

Fig. 2. Seeds of pomegranates
a. Normal b. Stoneless

primary importance for the stonelessness of the seed. In normal seeds lignification of the outer integument is completed, when the embryo occupies 1/5 of the embryo sac. Considering that the stoneless pomegranate is highly pollen-sterile, the formation of the embryo is a problem to be solved.

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Addenda

When the writer went to India in 1959, he found the "seedless" pomegranate,

Morus alba et M. nigra

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Kyoto University of Industrial Arts and Textile Fibers,
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Morus alba Linn.

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Morus nigra LINN. var. *laciniata* BUREAU in DC., Prodr., XVII, p. 238 (1973).

Morus alba LINN. var. *Kasasagi* HOTTA, Trans. Sapporo Nat. Hist. Soc. XIV, p. 277 (1936).

Arbor vel frutex mediocris ad 12 m alt. trunco 10~80 cm lato, cortice cinereoalbo vel cinereofusco. Ramulus plusminus gracilis, erectus vel solito magis inflexus, juventute plusminus pubescente. Gemmae late ovatae, apice acutae. Folia membranacea orbiculari-ovata, ovato-lanceolata, elliptica, subcordata, vel 2~4 (~6) leviter vel profunde lobata, supra viridia, nitida vel non nitida, levia vel parce scabra, subtus pallidula, apice plerumque acuta vel acuminata, lobis acutis vel rotundatis, margine dentato-serrata vel crenato-serrata, basi leviter vel profunde cordata rare cuneata vel truncata, lamina 10~15 cm longa, 8~12 cm lata, petiolis pubes-centibus

supra canaliculatis mox glabris(Fig. 1a). Apex cellulae cystolithicae obtusus vel acutus rare papillato-curvatus (Fig. 2).

Amentum femineum ovoideum usque oblongum, stylo nullo, stigmatibus 2 subulato-filiformibus 1.2~2.5 mm longis intus mimute papillosis primo rubris mox atratis rare albis.

Nom. Jap. *Karayama-guwa*.

Hab. In toto territorio Pakistaniae, Afghanistaniae et Iraniae; apud Mashhad in Irania (K. Yamashita, no. 719); apud Tabriz in Azerbaijania (H. Kihara, no. 357); apud Hunza in kashmiria (S. Nakao, no. 1201); apud Gilgit in Kashmiria (S. Nakao, no. 1207).

Distr. Pakistania, Afghanistania, Irania, apud Kashmiriam in India et China.

Morus nigra Linn.

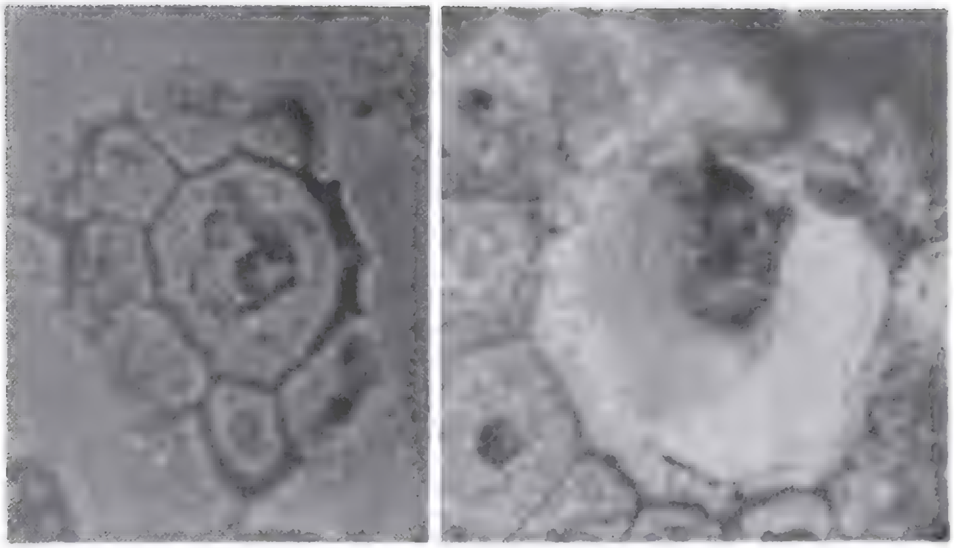
Morus nigra Linn., Sp. Pl. ed. 1, p. 986 (1753); et Syst. Vegt., p. 710 (1759); ed. 2, p. 1398 (1763); Houttuyn in Linn., Pfl. Syst., II, p. 2 85 (1777)-Willdn., Sp. Pl. IV, 2, P. 365 (1805)-Dietrich Lexc. Gart. Bot., s. 285 (1806)-Ledeb., Fl. Ross., III, 1, p. 644 (1849-50)-Seringe, Deser. Cult. Mûr. p. 220, tab. 6, fig. 1et 19 (1855) -Koch, Syn. Fl. Germ. et Helv. ed. 3, s. 552 (1857); Dendrol. II, 1, s. 444 (1872)-Bureau in DC., Prodr. XVII, p. 283 (1873)-C. K. Schneider, Illust. Handb. Laubholzk., I, s. 235 (1906)-Aschers. et Graebn. Syn. Milleleurop. Fl., IV, s. 557 (1911).

Morus siciliana Mill., Gard. Dict. ed. 8, 2, in erratis (1763) (sec. Ind. Kew.).

Morus laciniata Mill., Gard. Dict. ed. 8, 2; -Dietrich, Lexic. Gartn. Bot., VI, s. 261 (1768).

Morus scabra Morett. (non Willdn.) in Gion Inst. Lomb. Sc. I, P. 180 (1841) (sec Ind. Kew.).

Arbor vel frutex mediocris ad 6 m alt. cortice rubrofusco. Ramulus plusminus gracilis. Gemmae late ovatae. Folia membranacea, utrique subcordata vel ovato-lanceolata, supra viridia non nitida, subtus tomentosa dentato-serrata vel crenato-dentata, apice obtusa vel acuminata rare rotundata, margine basis auriculato-cordata vel cordata, petiolis breviter 1~1.5 cm longis (Fig. 1b). Apex cellulae cystolithicae acutus (Fig. 2b).



a : *M. alba* L. b : *M. nigra* L.

Fig. 2. Cystolith cells of *Morus*

Distr. Asia occidentalis: Pakistania, apud Quetta in Pakistania, apud Pontus in Afghanistania; Transcaucasia, Irania; Babylonia, America, Caucasia australis et Tauria.

Photographs

KUSE 1955

Photographs presented here have been furnished by

List of Photographs

1. Arrival of the members of KUSE at the Karachi Air Port, Pakistan. May 15, 1955.
Back row from left: Mr. HACHIYA*, OKAZAKI, Mr. SHIGIHARA* KITAMURA, IMANISHI, KIHARA, Mr. FUKAYA*, IWAMURA, MATSUSHITA, YAMAZAKI, Mrs. FUKAYA* and Mrs. HACHIYA*.
Front row from left: NAKAO, HARADA, UMESAO, HUZITA and Mr. KADOTA*

Remarks: * Members of the Embassy of Japan in Karachi, Pakistan.
YAMASHITA was then in Kabul, Afghanistan, as a forerunner.

2. Boxes and packages of equipments are placed in order in the back yard of the Embassy of Japan, Karachi, Pakistan. May 18, 1955. NAKAO rearranges them for the respective teams.

4. At the Agricultural Experiment Station, Quetta, Pakistan. May 26, 1955. KIHARA and KITAMURA arrange the collected samples of wheat on the bonnet of "Atago".

10. Vegetation in the arid zone of the Zarmast Pass, Afghanistan. July 5, 1955. Plants form spherical bushes or colonies. Main components are the species of Caryophyllaceae.

12. Tea plantation in the lowlands near Rasht on the Caspian Sea, Iran. July 21, 1955. Women pick young leaves.

6. Drive for herborization to Jalalabad along the Kabul River, Afghanistan. June 16, 1955. KITAMURA's interesting songs and stories kept the poor drowsy driver awake.

8. A traveler on a donkey back, Turkestan, Afghanistan, June 30, 1955. He holds firmly on to a water bottle which is very important and indispensable for a travel through the arid plain.

10. Vegetation in the arid zone of the Zarmast Pass, Afghanistan. July 5, 1955. Plants form spherical bushes or colonies. Main components are the species of Caryophyllaceae.

12. Tea plantation in the lowlands near Rasht on the Caspian Sea, Iran. July 21, 1955. Women pick young leaves.

14. Alpine zone near the top of the Parun Pass, Nuristan, Afghanistan. Aug. 6, 1955. Association of *Cousinia Trolii*, *Polygonum affine* and *Juniperus polycarpos* var. *seravschanica*.

16. Base camp in an orchard of old apricot trees at Zirni, Ghorat, Afghanistan. Aug. 11, 1955 A large tent was used for the office and dining room, and the smaller ones were for YAMAZAKI, UMESAO and Mr. Ahmad ALI.

18. The Taimani musicians of the ceremony of circumcision in the Moghol community in Zirni, Ghorat, Afghanistan. Aug 17, 1955. They visit from village to village.

20. Nomadic village of the Pushtun Tribe near Zirni, Ghorat, Afghanistan. Aug. 22, 1965. Wives keep tents, while men are out during the day-time. Children play hide-and-seek

22. Departure of coolies from Nagar, Pakistan June 14, 1955. The Mir himself offers his hand to every coolie wishing a safe trip through the glacier.

24. Sculptures with Greek and Indian influences found in the ruined Buddhistic monastry near Taxila, Pakistan. May 26, 1955.

28. A view of the snout of the world's third largest mountain glacier, the Hispar, Pakistan. June 17, 1955.

30. Dinner table set in the midst on the Hispar Glacier, Pakistan. June 23, 1955. Dinner was not so poor with "Ata" and rice obtained in Gilgit. IMANISHI plays the table master sitting on a folded mattress.

32. Down the Hispar Pass, Pakistan. June 25, 1955. They crossed the Hispar Pass with no difficulties. Then the sun shone so strong that the bare skin was burned by dazzling reflection from white snow.

34. Facing the Paiju Peak from the midstream of the Baltoro Glacier, Pakistan. July 8, 1955. The Baltoro Glacier is covered by a layer of gravels and boulders.

36. At Shigar, Pakistan. July 29, 1955. It was a pleasant journey on the skin-coracle boat which skilled Baltit sailors handled from Shigar to Skardu on the Braldu River.

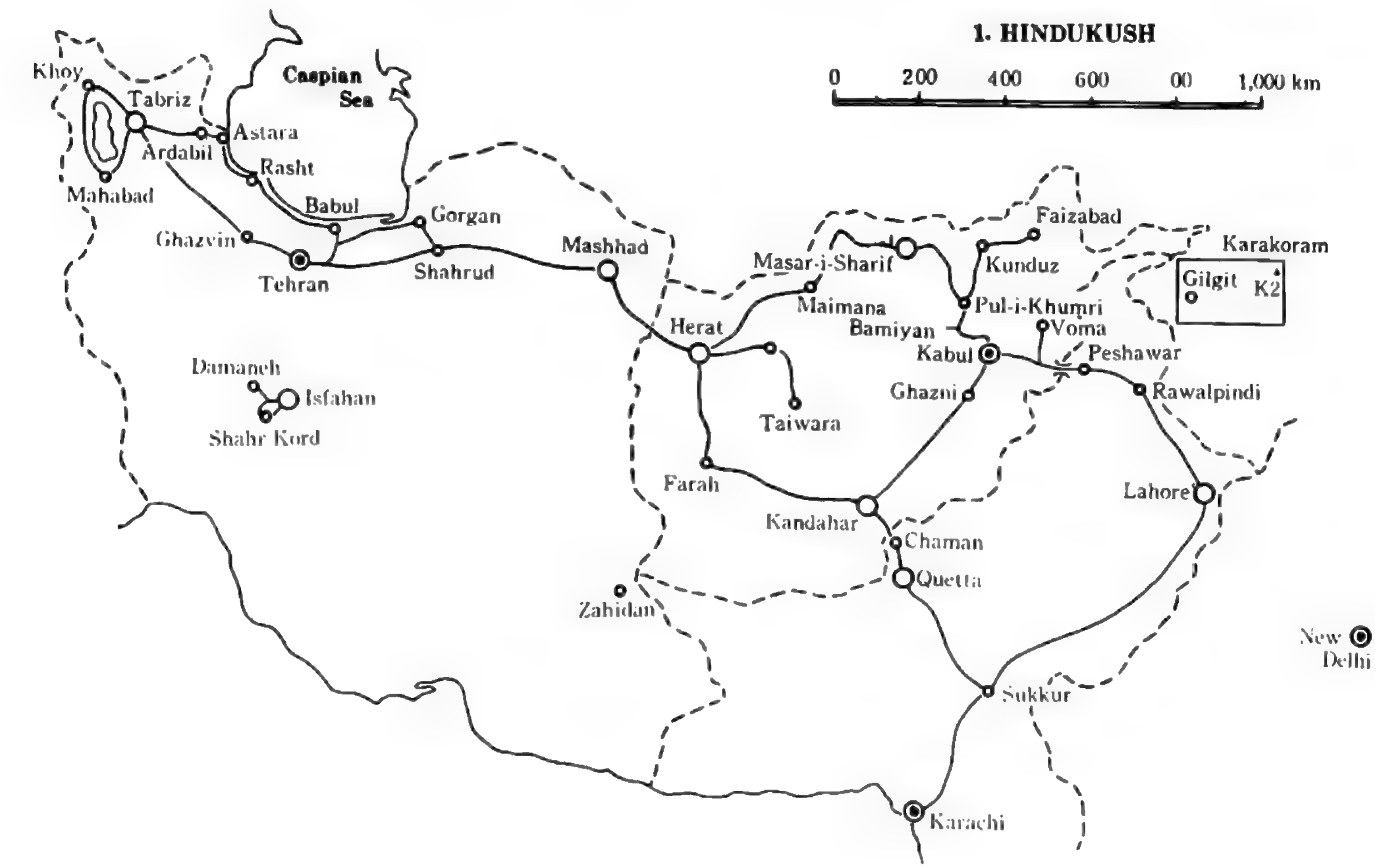
38. At the snout of the Minapin Glacier, Pakistan, Aug. 21, 1955. The necessary irrigation water to nourish the oasis is often drawn directly from the glacier. Two boys repair the irrigation ditch from the end of the glacier.

ROUTE MAPS

KUSE 1955

in outline

1. Hindukush Team 2. Karakoram Team



Itineraries of the Respective Parties of the Kyoto University Scientific Expedition (KUSE) to the Karakoram and Hindukush, 1955[1)]

Advance Arrangement I, by IWAMURA and HUZITA

For necessary advance arrangements, IWAMURA who traveled to Pakistan and Afghanistan in 1954 left Tokyo for Karachi by 18:00 flight of KLM on April 4, 1955, accompanied by HUZITA with a plan of staying overnight in Bangkok.

April, 1955—

6: IWAMURA and HUZITA arrived in Karachi at 23:00, and were kindly received by Mr. Fukai, Secretary of the Embassy of Japan. Hotel Carlton.

12~14: Preparations with Mr. Abdul RAHMAN, the officer of the Government of Pakistan, concerning the Scientific Expedition of the Kyoto University (KUSE). Application for tax-free importation of equipments was accepted.

17: Left[2)] Karachi at 7:00 by air on a reconnaissance tour to North Pakistan, including Kashmir. Colonel Mr. Ata ULLAH, the Vice-President of the Karakoram Club, received them kindly at the Rawalpindi airport.

18: Visited the Political Agent of Kashmir for detailed arrangements of the plans. The plan to go through the Chiringa Pass was not permitted.

19: Excursion to the Taxila ruins.

20: Mr. and Mrs. FUKAI arrived from the Embassy of Japan in Karachi. Permission for the trip to Gilgit was issued. Mr. A. ULLAH came to see them accompanied by Captain G. Safdar BUTT, who gave a talk at the Rotary Club meeting about the Italian K2 Expedition, which he himself had joined.

21: Flew to Gilgit through the Indus Valley. Mr. Humayn BEG took them to the guest house of the Political Agent. Vine roses were beautiful in full bloom with snowy mountains shining in the background. Mr. Mohammed J. KHAN of the Political Agent gave every consideration to the facilities for

Kobando in the other. A sharp peak of the Pirucharu Dobando could also be seen.

April 24: Returned to Gilgit.

25: Gilgit - Rawalpindi by air. The plane flew close to the Nanga Parbat at an altitude of 5,500 m.

26: Rawalpindi - Peshawar by train.

27: Mr. M. AHMAD, the Political Agent of the North West Province, gave his consideration to the Chitral and Waziritan trips in an unavoidable change in schedule due to the Pakistan - Afghanistan grievance.

28: Peshawar - Karachi by air.

May, 1955—

6: The Ryuwamaru, the Japanese freighter, arrived in Karachi with a load of equipments for KUSE.

7~13: IWAMURA flew to Tehran, for advance arrangements for the visit of KUSE at the later stage.

12~13: HAYASHIDA, the Cameraman of the Nichi-Ei Co., and NARA, the Reporter of the Press Asahi, arrived in Karachi.

15: KIHARA and the members arrived in Karachi (Photo. 1). Beach Hotel.

Advance Arrangement II, by YAMASHITA

Considering the urgent necessity of arrangements for the travel to Afghanistan because of the boundary grievance between Pakistan and Afghanistan, it was decided to send a secondary forerunner to Afghanistan via India. Accordingly YAMASHITA left Tokyo in the evening of April 30, 1955 by AF..

May, 1955—

2: YAMASHITA arrived in New Delhi. Hotel Ambassador.

3~12: Waited for the flight of Air India to Kabul which had been closed for unknown reasons. Newspapers reported that every Afghan office in Pakistan will be closed and the Afghan Embassy will draw back to Kabul from Karachi, and also that Pakistan will have an economic blockade against Afghanistan.

cheers when the parade passed by. Kabul Hotel.

May 14: Moved to the bungalow of the Marubeni Co., Osaka, Japan, through the kindness of Mr. and Mrs. M. NAKAMURA, the Chief of the Kabul Branch of the Co.. As the Embassy of Japan was not yet established in Kabul at that time, YAMASHITA had to do every arrangement by himself. Visited Dr. A. MAJID, the Minister of Education, and requested his assistance for the plans of KUSE. He understood the details and elected Mr. T. ETEMADI of the Department of Foreign Relations as a liaison officer to KUSE.

15: Visited Mr. Abdullah YAFTALI, the Director of the Procurement Agency to apply for the gasoline supply and then Mr. Abdul Wahd TARZI in the Press Department (=Board of Information) to get permission for taking pictures.

16: Mr. MUENZENMAIER, the German engineer of road construction who had been stationed in Kabul for four years, kindly gave a precise information of the distances between main places in Afghanistan as follows.

Kabul ← 64 km → Charikar ← 192 km → Doabi ← 100 km → Doshi
Doshi ← 56 km → Pul-i-Khumri ← 95 km → Haibak ← 64 km → Tashkurghan
Tashkurghan ← 58 km → Mazar-i-Sharif ← 107 km → Aq Chah ← 55 km → Shibarghan
Shibarghan ← 74 km → Andkhui ← 100 km → Dauratabad ← 48 km → Maimana
Maimana ← 66 km → Qaisar ← 120 km → Bala Murghab ← 117 km → Qala Nau
Qala Nau ← 164 km → Herat ← 125 km → Islam Qal'eh ← 10 km → Iranian Border

17: Visited Mr. Abdul Malik KHAN, the Minister of Financ, who had been in Tokyo several weeks ago.

18: Visited the Department of Agriculture.

19: On a car provided by the Imperial Household, YAMASHITA visited His Highness Sakar Mohammad NAIM, the Minister of Foreign Affairs, who understood every respect of the KUSE plans.

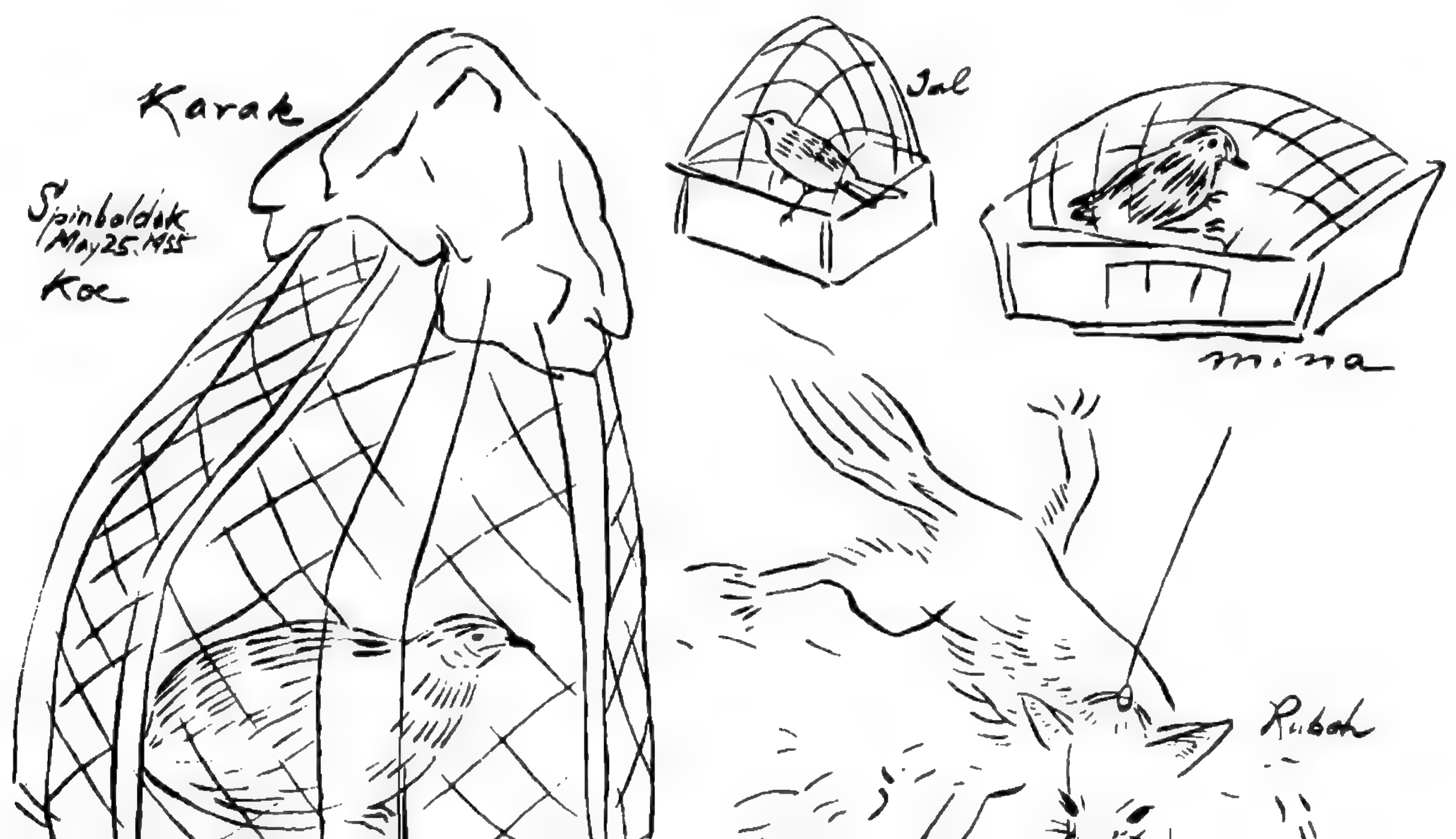
20: Joined a picnic of the Gosho Co., Osaka, Japan, to the former Palace Garden in Paghman, where hawthorn bushes were in full bloom. Received a cable from KIHARA in Karachi, directing to come to the border after the completion of the necessary arrangements.

21: The arrangements were completed with Mr. ETEMADI as follows: (1) maps of Afghanistan, (2) driver's licence of Afghanistan, (3) letter of introduction to

Team of KUSE arrives in Quetta on the 24th, and passes the border on the 31st.

May 23: Left Kabul by the Ariana Air Lines at 7:45, and arrived in Kandahar at 9:30. Kandahar Hotel. Mr. M. Taher KHAN, the Chief of the Board of Education, came to see YAMASHITA in the hotel with a direction from Mr. ETEMADI. The hotel ground was adorned with beautiful flowers of oreanda.

24: After visiting Mr. Syed Alum KHAN, the Vice-Governer of Kandahar, left there by jeep provided by Mr. M. T. KHAN with the intention of crossing the border immediately. Arrived in Spinboldak. It became clear that the formalities for permission to leave Afghanistan had to be completed in the Police Office in Kandahar. As the telephone was out of order, kindly a clerk was sent to Kandahar with the passport. A room of the custom office equipped with an Afghan wooden bed was provided for the overnight stay. A great trouble was that an English-Persian dictionary, which would have been very useful, was left in the Hotel Kandahar. YAMASHITA was therefore just like a poor deaf and dumb. (Fig. 1).



mically blockaded by Pakistan, Yamashita was actually the only man to cross the border. Arrived in Chaman at 13:10 after a long walk on a burning hot road. Rest in the Dak Bungalow. Mr. R. A. Peart, the Agent of the Morrison and Knudsen Co., Tacoma, Washington, U. S. A., received him very warmly with Coca-Cola and canned fruits. A military tension was noticeable by the whizzing of jet planes, and the noise of caterpillars of tanks.

May 26: Left Chaman at 7:00 by train. The oasis of Quetta was seen in the distance from Beleri. Arrived in Quetta at 15:00 and met Kihara, Kitamura, Umesao, Yamazaki and Nakamura in the Lourdes Hotel.

Arrival of the KUSE Members in Karachi, Pakistan, Kihara, Imanishi, Matsushita, Kitamura, Harada, Nakao, Yamazaki, Umesao, Okazaki and Nakamura

May, 1955—

14~15: Members left Tokyo by Air France on May 14, and arrived in Karachi on May 15 and met Iwamura, Huzita, Nara and Hayashida. Beach Hotel. Mr. Yamagata, Ambassador of Japan, Mrs. Yamagata and all the secretaries and officers of the Embassy of Japan came to the airport to receive them. (Photo. 1).

16: All the members visited the Embassy of Japan.

17~21: Preparations. In the sweltering heat equipments were rearranged for the respective teams. (Photos. 2, 3).

22: Iwamura and Huzita left by air for Rawalpindi for advance arrangement, while, Imanishi, Matsushita, Nakao, Harada, Okazaki and Hayashida left Karachi by the Khyber Mail, the express train, for Rawalpindi at 21:00.

23: Kihara, Kitamura, Yamazaki, Umesao, Nara and Nakamura left for Quetta by 11:20 train.

HINDUKUSH TEAM

Quetta - Chaman Trip

various agricultural informations: one of the main crops is wheat; potato has been introduced from the Netherlands; and others are melons, peas, tomatoes, apples, grapes, pomegranates and apricots.

May 26: Air temperature was 22.5°C at 6:00. They visited the Agricultural Experiment Station where *Aegilops squarrosa* was found in the wheat fields. (Photo. 4). *Hordeum spontaneum* and *Avena fatua* were found everywhere. YAMASHITA arrived from Afghanistan.

27: *Ae. squarrosa* was found abundantly in the forest (protected for 50 years) at Hazar Ghanj, 12 miles south-west of Quetta. Sparsely grown *Pistacio cabreca, Fraxinus xanthoxyloides*, and *Artemisia kuramensis* were the main components of the forest. KITAMURA, YAMASHITA, UMESAO and YAMAZAKI began a lesson of Persian language by a local teacher.

28: Excursion to Ghiristan accompanied by Mr. N. H. KHAN, 45 km north of Quetta, where a few trees of seedless pomegranate were found in an orchard. Collected materials were investigated in the temporary laboratory set-up in the hotel.

29: YAMASHITA drove "Atago" for UMESAO and YAMAZAKI to the north of the city for a preliminary survey of the nomad tribes. Tea party at Mr. N. H. KHAN in the evening.

30: Shopping of fruits and vegetables as well as the seeds of local crops from the market. The lesson of Persian language was finished. All the members took enough rest during the stay with comfortable weather in Quetta after the fatigue of their long trip from Japan.

31: KIHARA, YAMASHITA and NAKAMURA left Quetta at 7:00 on "Atago", and KITAMURA, YAMAZAKI, UMESAO and NARA on a hired truck loaded with equipments. Herborizations on the way were very rich. All arrived in Chaman at 12:00. They thought they would be able to pass the border right away, but trouble arose there. A document of importation for "Atago", which was not complete, was requested to show at the customs. Every effort to get an understanding by the custom officer was of no use. He emphasized "The border is actually blockaded against Afghanistan!". KIHARA called on the Embassy of Japan in Karachi by telephone and asked them to deliver the necessary documents. The Dak Bungalow was arranged for one night.

June 1955—

Entrance to Afghanistan

June 4: 17:00. Mr. Hachiya, the Agricultural Atache of the Embassy of Japan in Karachi, and his family arrived with the documents necessary for the custom clearance. Accordingly they left Chaman around 18:00. Equipments were carried by a truck from Pakistan to the border area and transfered to a truck from Afghanistan. The members crossed the border and arrived in Spinboldak, Afghanistan, at 19:20, where the custom clearance was not difficult. At 23:00, arrived in Kandahar under the fullmoon, 110 km from Chaman. Kandahar Hotel.

5: Rest.

6: Kitamura, Yamazaki and Umesao stayed longer for herborization, while Kihara, Yamashita, Nara and Nakamura left Kandahar for Kabul at 9:00 on "Atago". Specimens of *Aegilops* were collected here and there on the way. After the sunset, Kihara found *Ae. crassa* by the dark roadside with the help of an flash light. Arrived in Ghazni, 366 km from Kandahar, at 0.30 in the midnight. A poor hotel room equipped with only two beds was just available. Nara and Nakamura crawled into sleeping bags on the floor.

7: Yamashita prepared breakfast with the stuffs bought around the hotel. Left Ghazni at 9:30. A wheat field mixed with *Ae. squarrosa* was found at the distance of 41 km from Ghazni, where the rate of mixture in each square meters was observed: wheat - 153 ears, *Ae. squarrosa* - 27 ears and *Secale* - 45 ears. Arrived in Kabul at 16:00. Mr. M. Nakamura, the Chief of the Marubeni Co., kindly provided rooms for Kihara and Yamashita in the bungalow. Nara and Nakamura stayed in the Kabul Hotel.

8: Visited Mr. Etemadi in the Department of Foreign Relations for consultation concerning the itineraries. Met Dr. C. L. Behm from Sweden who came to Afghanistan for collecting legume species.

9: Visited Department of Agriculture and presented several seedlings of tea-plant brought from Japan, which was planted under the care of Dr. Hildreth from Wyoming, U. S. A.. Information of harvest time of wheat in Afghanistan was as follows: early July in Kabul, June~July in Jalalabad, first week of July in Turkestan and last week of July in Badakshan.

and onion slices for every lunch and dinner. But apricots and plums were most delicious and refreshing.

June 9: Equipments were loaded on truck before noon, but the departure was delayed until late afternoon, because it was feared that the tires of the fully loaded truck would not be tolerant against the heat of the road. Left Kandahar at 17:00. The air became rather chilly in the evening. Arrived in Kalat at 1:30, and dropped in a hotel.

10: Left Kalat at 7:00, dinner in Ghazni and stopped in a tea house "chaykhana", in Singar late in the evening.

11: KITAMURA, YAMAZAKI and UMESAO arrived at the bungalow of the Gosho Co. in Kabul at 11:00. Mr. J. KAKOTO, Chief of the Afghan Branch of the Co., kindly opened rooms in the bungalow for their stay.

12: KIHARA, with all the members, visited the Vice-President of the University of Kabul in the morning. They attended a reception given by the Minister of Education in the evening. Twenty-five Japanese people stationed in Kabul were also invited. (Photo. 5).

13: Tour to the Laboratories of Chemistry, Physics, Botany, Geology and Medicine of the Kabul University in the morning, and to the Agricultural School in the afternoon.

14: KIHARA and YAMASHITA gave lectures at the Faculty of Medicine, Kabul University. At 7:30, the air temperature was 21.5°C, and the humidity 20%. At 15:00, IWAMURA and OKAZAKI arrived at the bungalow of the Gosho Co. via the Khyber Pass.

Jalalabad Excursion of KITAMURA, YAMASHITA and NAKAMURA

15: KITAMURA, YAMASHITA and NAKAMURA went on herborization to Jalalabad accompanied by Mr. Mohammed AMAN by "Atago". A number of plant specimens were collected around the Latabant Pass. *Ae. squarrosa* was found only in the west of the pass. So called seedless pomegranate "anar-e-bedana" which they had been looking for was found in an orchard of Mr. G. AHMED near Sarobi. Stayed in the Hotel Sarobi.

16: Driving along the Kabul River, they arrived in Jalalabad at 20:30, and dropped

Hindukush Trip of KITAMURA, YAMASHITA and NARA

June 23: Kitamura, Yamashita and Nara left for the Hindukush Range in the afternoon, accompanied by Mr. Mohammed Ali. Camped beside a "chay-khana" on river at Siyagird.

24: Herborization was rich around the Shibar Pass, 3,300 meters above sea level. Met the Iwamura's party in Bamiyan. Bamiyan - Doabi. Doabi Hotel.

26: Doabi - Doshi - Pul-i-Khumri. Stayed in the German Club House of the water power plant.

27: Left Pul-i-Khumri at 7:10. *Aegilops* species, especially *Ae. squarrosa*, were growing widely. A vast plain of *Ae. squarrosa* spread out as far as the eyes could reach. A light French car with a name plate "Nancy" passed gasping by along the steep road, while they were collecting plants. The sun set in the west of the ancient "silk road". Poor "Nancy" was found standing on the roadside between Tashkurghan and Masar-i-Sharif due to the break of a receptacle shaft. They shared some biscuits with the French travelers and passed by. Arrived in the Hotel Mazar-i-Sharif late in the evening.

28: Iwamura, Okazaki, Yamazaki and Nakamura arrived in Mazar-i-Sharif from Bamiyan.

Turkestan Trip of YAMASHITA and NARA

29: Yamashita and Nara had to leave Mazar-i-Sharif (Photo. 7) as the permission of their stay had expired. Visited Balkh, a ruined ancient capital town of Afghanistan. A clematis was in bloom on an old decayed wall. Bivouaced in "Atago" by the roadside.

30: Left the bivouaced place at 5:30. (Photo. 8). Arrived Aq Chah (or Akcha) at 8:00 and had a rest in the Hotel Aq Chah. Started again at 11:00 and arrived at the Hotel Shibarghan around 14:00. "Nancy", the French car, was also there for a recess after lunch. They introduced themselves to each other. Their names were Jean and Jacques.[1] "Nancy" left at 16:00. "Atago" started one hour later and followed after the track of "Nancy" on sands

whisky brought from Japan under the fullmoon. The Big Dipper was seen low over the horizon.

July, 1955—

1: Left the site of bivouac at 5:30. "Nancy" and "Atago" were able to surmount the difficulty in passing through the desert and arrived at the Hotel Andkhui. A clerk of the hotel received them with a welcome greeting "ab ast" which means "water is available". After a short recess at the Hotel Andkhui, "Nancy" left at 11:00, and "Atago" at 13:30. The air was hot and dry. *Ae. squarrosa* and other species abounded along the road. "Nancy" was sitting by the roadside due to a spring damage near Faizabad. "Atago" waded across the river and arrived in Maimana.

2: Excursion around Maimana accompanied by Mr. M. RAFIG, the Chief Policeman. *Aegilops* species were collected in the isolated villages behind the hills.

3: Poor "Nancy" was again found sitting down due to a dead storage battery. Jean carried the battery on "Atago" to Bala Murghab for a charge. Bivouaced at 50 km before Qala Nau. Animals approached the tent with blue gleaming eyes in the night.

4: Day broke on the plain of *Ae. squarrosa*. A flat tire of the trailer was fixed with the help of a driver of a passing truck. Stopped in Laman.

5: Three heavy boxes, two tents and one trunk were trusted on a truck with some pay to clear the Zarmast Pass, alt. 2,000 m. (Photo. 10). Old juniper trees sparsely grew around the pass. Arrived in Herat with the population about 60,000.

6: Visited the Governer of the District and the Mayor of the City together with Dr. H. F. SCHURMANN, an American archaeologist, and his colleague, who were destinated to Ghorat in Afghanistan. (Photo. 11).

7: Left Herat early in the morning. The air temperature was 35°C and the ground temperature 53°C. Custom clearance was easy at Islam Qal'eh, the Afghan border town, and arrived at the Iranian custom at Yusfabad. Unexpectedly there waited the difficulties for "Atago" again, because the formalities of its importation was not complete. Anyhow, poor "Atago" and also cameras were sealed finally. Stopped in a small "chay-khana" in Pelermo, 50 km before Mashhad (or Meshed).

further schedule. U. S. A. Consul, Mr. CASSILY received YAMASHITA and NARA warmly with American food in his residence.

July 10: Mashhad - Nishapur - Sabzawar (or Sabzevar), all are known to be historical towns. Passports were checked at the entrance and exit of each town.

11: Passing Shahrud[1] around 16:00 arrived in Damghan, where they stayed overnight on beds under the open sky with glittering stars.

12: Left Damghan for Tehran early in the morning. Short stop at Ajajabad. Arrived the bungalow of the Gosho Co. in Tehran and saw KIHARA after a hard drive for 20 days from Kabul.

Isfahan Trip of KIHARA

June, 1955—

25: KIHARA arrived in Tehran from Kabul by air in the afternoon, and stayed in the residence of the Ambassador of Japan.

26: Rest.

27: Application for the permission of the trip to Isfahan was completed with the help of the Embassy of Japan.

28: Tehran - Isfahan by air, accompanied by Mr. NOSE of the Gosho Co.. A car was hired for the excursion, Isfahan - Saman - Shahr Kord - Safid - Dasht - Isfahan.

29: Round trip to Damaneh by car. *T. turgidum* with branched ears was collected between Isfahan and Damaneh, but no *Aegilops*. Common wheat was cultivated widely.

30: Returned to Tehran.

July, 1955—

1: Excursion to Ghazvin (or Qazvin) accompanied by Mr. H. YAMADA, Ambassador of Japan. Visited the Agricultural College in Karaj. *Ae. triuncialis* and *Ae. crassa* were collected.

2: Stayed in Tehran.

3: Visited Prof. ATAI of the Agricultural College in Karaj, who shared the samples of varieties of wheat. On the way back, *Ae. cylindrica* and *Ae. triuncialis* was collected.

4~5: Stayed in Tehran.

(*Panicum crusgalli*) was ripe in the backyard of the hotel. *Ae. squarrosa* ssp. *strangulata* was found in a locality 24 km from Sari, and also on the way to Gorgan.

July 8: Gorgan – Shahrud. Ssp. *strangulata* was found everywhere. Ssp. *strangulata* and *T. durum* were growing close to each other near Garagaj. In the mountainous district, *Ae. triuncialis, Ae. squarrosa* and var. *typica* were collected but ssp. *strangulata* was not found anywhere. From this it was learned that ssp. *strangulata* grows only in a limited belt along the southeastern coast of the Caspian Sea, namely in the Gorgan region.

9: Shahrud.

10: Tried to catch "Atago" of YAMASHITA and NARA from Mashhad, but was informed by a message from the Police Office that the jeep had passed Shahrud.

11: Left for Tehran by a mid-night bus.

12: Arrived in Tehran early afternoon, but YAMASHITA and NARA were not there. They were thought to be lost, but late in the evening lost YAMASHITA and NARA reappeared on "Atago".

Stay in Tehran of KIHARA, YAMASHITA and NARA

13: Visited the Embassy of Japan. KIHARA moved over to the residence of the Ambassador of Japan in Shemiran, while YAMASHITA and NARA stayed in the bungalow of the Gosho Co..

14: Met Dr. MUDRA, the F. A. O. wheat specialist stationed in Iran, and then visited Mr. MOJTAHEDI and Mr. HAYDARZADEH of the Department of Agriculture and talked over about the trip along the Caspian Sea.

15: A party to celebrate "O-Bon", the Budhistic Feast in memory of the dead, was held in the residence of the Ambassador of Japan and after that they visited the graves in the cemetry of the Japanese residents in Tehran. YAMASHITA had a slight fever (38°C).

16: Rest.

17: YAMASHITA received a medical examination by Dr. D. SALMON. His fever was 38.1°C. Room temperature was 33°C. While YAMASHITA stayed in Tehran, KIHARA and NARA left for the trip along the Caspian Sea on "Atago" driven

strangulata was collected around Sari again. The district of Sahi-Babul seemed to be suitable for *Andropogon, Sorghum, Zea mais,* sweet melon and cotton but not for wheat. *Aegilops* was not found there.

July 20: Babul Sar-Chalus-Ramsar. Ssp. *strangulata* was found 51 km from Babul Sar. Paddy rice was flowering in some fields and was fully ripe in other fields.

21: Ramsar-Rasht (or Resht). *Ae. squarrosa* var. *typica* was found here and there but no more ssp. *strangulata*. The landscape with paddy rice fields and tea plantations let them think of Japan. (Photo. 12).

22: Rasht-Pahlavi.

23: Pahlavi-Ardabil (or Ardebil). *Ae. squarrosa* was found everywhere on the way. Arrived in Ardabil at 17:40 and dropped in the New Tabriz Hotel. YAMASHITA and Mr. NOGUSA arrived from Tehran.

Tehran-Ardabil Trip of YAMASHITA

July, 1955—

18～19: Rest. In "A history of Persia" by Sir P. Sykes (3rd. Ed, 1930), the Gorgan district was described as follows: "The Gurgan district was the classical Hyrcania, and the Vehrkano of the Avesta, and was famous for its fertility. Strabo wrote: It is said that in Hyrcania each vine produces seven gallons of wine and each fig-tree ninety bushels of fruit. That the grains of wheat which fall from the husk on to the earth, spring up the following year; that bee-hives are in the trees, and the leaves flow with honey."

20: YAMASHITA received a tele-direction from KIHARA "Join in Ramsar otherewise in Tabriz".

21: Rest.

22: Visited Mr. NOGUSA, Secretary of the Japan Embassy, to talk over the trip to Azerbaijan as the fever broke gradually down. Participated in the "Go" tournament held in the residence of the Ambassador and won the game.

23: Left Tehran by air at 8:00, accompanied by Mr. NOGUSA, and arrived in Tabriz at 11:00. After a short stop in the Metropol Hotel, where the members of the Welsh Himalayan Expedition was just leaving, hired a taxi and arrived

July 25: Visited the orchards of Mr. HAYDARZADEH where an old seedless mulberry tree was grown. *Ae. cylindrica* was also collected there.

26: Mr. NOGUSA left for Tehran by air. KIHARA collected *Ae. triuncialis* and *Ae. cylindrica* in the southwest of the city.

27: While YAMASHITA with a slight fever of 37.5°C stayed in Tabriz for rest, KIHARA and NARA started on the trip around the Lake Rezaiyeh. *Ae. cylindrica* and *triuncialis* were collected, and *Ae. crassa* was found growing in a garden near Myandoab. Stop in Mahabad.

28: Mahabad - Khoy (or Khoi). *Ae. squarrosa* was found 75 km northeast and also 75 km northwest from Mahabad in the open grassland. Many other species were also collected. A large quantity of algae was seen on the shore of the Lake Rezaiyeh. (Photo. 13). *Ae. squarrosa, cylindrica* and *triuncialis* were growing in an open grassland of *Artemisia*. Arrived at the Khoy Hotel at 19:00.

29: KIHARA and NARA returned to Tabriz. YAMASHITA found the spikelets of *Ae. squarrosa, crassa,* and *triuncialis* mixed in chicken feed obtained from the market.

Return to Tehran of KIHARA, YAMASHITA and NARA

30: KIHARA and YAMASHITA left Tabriz for Tehran by air, while NARA left also for Tehran on "Atago". On the way, NARA met Jean and Jacques known from the Hindukush trip. They told that they had to sell their cameras in Tehran to make money for the repair of poor "Nancy".

31: NARA arrived in Tehran around noon.

August, 1955—

1: Rest.

August 2: Shopping in the market. (Fig. 2). It was interesting to see flat fruits of almond.

3: Were invited for a tea party by Mr. YAMADA, Ambassador of Japan, and Mrs. YAMADA, together with Mrs. S. KATO and others participating in the MRA Conference in Tehran.

4: Rest.

5: Were invited to the performance of MRA, "Vanishing Island", in the hall of the Imperial Villa in Nevaran.

6: Rest.

7: Seed collection from the bazar. Farewell party by the Gosho Co..

8: KIHARA went on a picnic with the members of the Gosho Co., while YAMASHITA and NARA remained in town to attend bank business.

9: Visited Dr. MAHDAM, the Director of the Department of Agriculture, University of Tehran in Karaj.

10: Lectures at the Ministry of Agriculture, on the origin of wheat by KIHARA and on the triploid watermelon by YAMASHITA. Banquet by the Embassy of Japan at the University of Tehran with a talk on the origin of wheat by KIHARA.

North Pakistan Trip of KIHARA and YAMASHITA

11: KIHARA and YAMASHITA left for Karachi by air while NARA flew to Beirut.

12: Rest.

13: Visited the Ministry of Agriculture and Forestry for the arrangement of the trip to North Pakistan. Opening the suit cases, they were pleased with dry air packed in Tehran.

14~15: Rest.

16: Visited Dr. AFZAL, Ministry of Agriculture, for the final arrangements for the northern trip. Received a cable from the Karakoram team notifying the change of schedule due to the shortage of money.

17: Rest.

18: KIHARA and YAMASHITA left Karachi by the Khyber Mail, the express train, at 21:00.

by a colchicine treatment. Lectures on the origin of wheat by KIHARA and on the polyploidy breeding by YAMASHITA.

August 23: After a brief visit to the Museum, left Lahore and arrived in Rawalpindi at 18:00. Stop in the Flushman Hotel.

24: Visited the Gordon College accompanied by Mr. M. ALI. Specimens of *Aegilops*, including *Ae. squarrosa* collected at Srinagar in Kashmir, were found in the herbarium. Excursion to the Taxila ruins, where carbonated samples of wheat grains were exhibited in a case.

25: Rawalpindi–Peshawar. Were greeted at the station by Dr. KHAN, the Director of the Horticultural Research Institute, and visited the Khyber University. Deans Hotel.

26: After an excursion to the Khyber Pass, visited the Museum. A presentation of a film "Origin of Wheat" by KIHARA and a lecture on the polyploidy breeding by YAMASHITA were given at the Horticultural Research Institute.

27: KIHARA and YAMASHITA returned in Karachi by air from Peshawar.

Nuristan Trip from Mazar-i-Sharif of KITAMURA

June, 1955—

30: KITAMURA obtained the seeds of various crops from the Mandai market in Mazar-i-Sharif.

July, 1955—

1: He left Mazar-i-Sharif at 6:30 with Mr. M. ALI by a car hired by paying 1,000 "Afghanis" for the Mazar-i-Sharif–Pul-i-Khumri drive. Camped at a "chay-khana" before Pul-i-Khumri due to the shortage of fuel.

2: Breakfast in the "chay-khana" at 5:00. Gasoline was kindly given by a truck. Arrived at the Textile Club in Pul-i-Khumri.

3: Herborization around the town.

4: Called on the Gosho Co. by telephone, and requested to hire a car in Kabul for the Faizabad trip.

5: Received the answer from Mr. UCHIDA of the Gosho Co. by telephone that the arrangement for a car is not possible so soon. At 6:30, by a chance ride

of Faizabad.

July 9: At 1:00, arrived in Pul-i-Khumri from Faizabad. The driver of a truck going to Kabul promised to give him a ride to Kabul. But the truck did not start until 20:00 when gasoline arrived from Mazar-i-Sharif.

10: Arrived at the Doabi Hotel early in the morning. After herborization, left Doabi about 23:30 and stayed overnight in a village on the east side of the Shibar Pass.

11: After a hard journey on a truck, arrived in Kabul at 21:30 where letters from Japan were waiting for him.

12: Taking care of the collected samples. Blotting paper brought from Japan was found to be very useful for drying the samples.

13: Visited Mr. ETEMADI in the Department of Foreign Relations and reported about the trip to the north.

14: Excursion to the Babel Cemetry, where the former botanical explorers including Griffith collected plants. The vegetation was rather poor.

15: Excursion to Pajmar from 10:30, accompanied by Mr. KAKOTO, Gosho Co.

16: Visited the Department of Foreign Relations to apply for the permission of the Nuristan trip.

17: Preparation.

18: Excussion for herborization accompanied by Mr. UCHIDA, Gosho Co, to Kal Ull AMAN, known in the literature as the place where German botanists collected plants.

19: Mr. KAKOTO, Gosho Co., showed the Japanese threshing machines to the Minister and Vice-Minister of Agriculture.

20: Collected seed samples in the market.

21: Further arrangements for the Nuristan trip with Mr. ETEMADI.

22: Picnic with the members of the Gosho Co. to Chonghol Fountain in the west of Kabul.

23: Permission was issued for the Nuristan trip, only to the west of the Kumar River.

24: Decided to hire a station wagon from the Syricat Service, as far as Chigha-Sarai.

25: Left Kabul accompanied by Mr. M. ALI, at 9:30, and arrived in Jalalabad at 20:00.

the popular woods on the Pechi River. The representatives of the crowd were invited into the tent for supper. The story of the grievance between the two villages was as follows; a girl who was engaged to marry a boy of Voma was raped by a boy of Eschtaway. Accordingly a conference was held by the representatives of five villages to solve the grievance. It was said that the representative from Eschtaway proposed to offer a cow and two girls with no pay, but the proposal was rejected by the representative of Voma. Instead, the boy of Voma wished to challenge the Eschtaway boy who raped his girl to a duel. This was accepted, and the conference was over. Herborization along the Pechi River through the rain. Camped in Eschtaway.

August 8~14: Eschtaway – Pushuki – Voma – Ghandai.

15~20: Ghandai – Morchal – Chigha-Sarai – Jalalabad – Kabul.

21~28: Preparations for the returning trip.

29: Left Kabul at 6:10 by air with the baggage of collected plant specimens and arrived in Karachi at 12:00.

Historical Survey in Waziristan of IWAMURA and OKAZAKI

June, 1955—

1: Permission for the trip to Waziristan was issued from the office of the Tribal Territory of Waziristan.

2: IWAMURA and OKAZAKI left the Deans Hotel in Peshawar at 6:30 for Waziristan on "Kurama"[1] and arrived in Panu by noon. Visited the office of the North Waziristan Territory and talked with Mr. A. U. KHAN, the local administrator, about their schedule. Late in the afternoon they went on an excursion to the Akra ruins with Mr. A. U. KHAN escorted by 15 soldiers. Old coins engraved with Greek letters were presented by the villagers. A violent sand-storm arose in the evening. Dinner with a Swiss and an Icelander from FAO.

3: Left for Spinwan at 9:30 escorted by soldiers on a truck. Collected old earthenwares and bought old coins from the natives. It is known that only one report was published about Waziristan by Aurel STEIN 50 years ago.

June 7: Stayed in Peshawar.

8: Excursion to the Tafti Bahai and Chalsada ruins guided by Mr. SHAKUR, the curator of the Peshawar Museum. The latter was a very spacious unexcavated ruin.

9: Rest.

10: Mr. Izzat AWAN showed them a technicolor film of Kafir in the district of Chitral. It was interesting to see that Kafir in Chitral is not influenced by Islam, and is different from Kafir in Nuristan, Afghanistan.

11~12: Stay in Peshawar.

13: Left Peshawar at 10:00 and crossed the Khyber Pass between Pakistan and Afghanistan. Stayed in Jalalabad.

14: Started at 7:00 and arrived in Kabul by "Kurama" at 15:00, where they joined with KIHARA, the leader, and the members.

Moghol Survey in Ghorat of IWAMURA, YAMAZAKI, UMESAO, OKAZAKI and NAKAMURA

15~July 10: Formalities for the entry to Ghorat were completed.

July, 1955—

11: Left Kabul early in the morning on "Kurama" with equipments on a hired station wagon and visited the grave of the King MAHMUD in Ghazni.

12: Arrived in Kandahar at 18:00. Kandahar Hotel.

13: Kandahar.

14: Kandahar-Girishk. After a recess, left there at 21:00 for Farah through the Hermand Desert.

15: Arrived in Farah at 9:00 and left there at 20:00.

16: Arriving in Herat at 9:00, met Mr. SCHURMANN, a German historian, who was accompanied by Mr. RANDAUER, an American anthropologist. Visited the Governor General of Herat.

17~19: The station wagon was sent back to Kabul, and a truck was arranged in Herat. Mr. SCHURMANN and his associate left Herat by their own Volkswagen with Taiwara ahead of them.

20: Left Herat at 8:00 and traveled toward the east along the north side of the

the river. "Kurama" arrived late in Qala-Shararak after a hard drive on a bad road through mountains, while the truck group stopped on the way.

July 23: The truck group arrived in Qala-Shararak at 18:00. The truck driver refused to drive further than Taiwara.

24: The truck was sent back. IWAMURA, YAMAZAKI and Mr. A. ALI left for Taiwara on "Kurama" with a full load of equipments and arrived there at 19:00. Finding that no Mongols live in Taiwara, they were disappointed. Camped in the garden of the Government Office. Met Messers SCHURMANN and RANDAUER.

25: "Kurama" was sent back to Qala-Shararak. Investigated a half ruined pagoda in the village. Strong wind blew during the night.

26: UMESAO, OKAZAKI and NAKAMURA arrived. Most of the baggage was left in Qala-Shararak. Since the transportation of back and forth by jeep was thought to be impossible due to the shortage of gasoline, requested Mr. HAKIM, the Governor in Qala-Shararak, to arrange the transportation by caravan.

27: Horses were arranged. Started from Taiwara at 16:30, and arrived in Chadarhar in the evening. There were about 100 families of the Taimani Tribe.

28: Left Chadarhar at 10:00 and arrived in Alpatu at 15:00. There was only one earthen house of "Albabu", the head of the village, and 12~13 tents of the Taimani Tribe. Apricots were ripe, and the valley was beautiful with green vegetation, but to their disappointment there were no Moghols around there. However, "Albabu", an Islam priest, told that the Moghols lived around Zirni (or Zarni) several decades ago.

29: Started for Zirni on horseback at 8:30. From the pass a village of Moghols was seen in the distance. Arrived in Zirni in the moonlight and found the house of "Albabu" who provided the rooms. "Albabu" told that Zirni is a Moghol village with about 200 families. That was just the day of a festival, and many Moghols were there. Some of them understood the Mongolian language, which were recorded on tapes. An old Moghol brought a booklet[1)] of Mongolian language written in Arabic letters.

30: Rest.

31: Because of the shortage of food it was decided to draw back to Taiwara.

at 19:00. Equipments were already forwarded by caravan to Taiwara.

August 3: Started from Qala-Shararak by "Kurama" at 7:30, and arrived in Herat at 21:00.

4: Rest.

5~8: A photographic copy was made of the Mongolian literature written in Arabic letters, which IWAMURA found in Kundul., a Moghol village, in 1954. A visa for Iran was arranged at the Consulate of Iran in Herat.

9: Left Herat at 7:00 and passed the border at Islam Qal'eh, around noon. Met a sandstorm in the desert. Custom clearance at Yusfabad was easy. The road in eastern Iran was better and arrived in Mashhad at 21:00.

10~11: Mashhad.

12: Left Mashhad early in the morning and stopped in Shahrud.

13: Arrived in Tehran at 20:00.

14~17: Stayed in Tehran, visiting the Museum and other places. Went on an excursion one day to the coast of the Caspian Sea. The northern side of the Elburz Range was covered with forests, in an extreme contrast to the southern side where it was almost barren. The houses were built of wood and the store house with an elevated floor looked just like the Japanese store houses. (KIHARA and YAMASHITA left for Karachi by air.)

18: Left Tehran at 6:00, and stopped in Zenjan.

19: Started at 9:30, arrived in Tabriz in Azerbaijan at 18:00.

20: Visited the historical remains in Tabriz.

21: Left Tabriz at 6:00, and after a drive of over 6,000 km arrived in Tehran.

22~24: Tehran.

25: IWAMURA left Tehran at 7:30, and arrived in Karachi at 15:00. OKAZAKI remained in Iran for further investigations.

KARAKORAM TEAM

Gilgit Oasis

May, 1955—

getting permissions for the trip to the Karakoram areas.

May 26: Received a visit of Capt. G. S. BUTT, the liaison officer from the Government of Pakistan. Excursion to the Taxila ruins. (Photo. 24).

27: MATSUSHITA and others visited the office of the Survey of Pakistan at Mureh, and asked for quarter inch maps of the Karakoram areas, which were delivered later to Gilgit by mail.

28: Rawalpindi - Gilgit by air. The baggage was also transported by air to Gilgit. Dropped in the Hunza House, and then visited the Political Agent of Gilgit late in the afternoon.

29: Stayed in Gilgit. Seven Hunza porters were hired.

30: HARADA, became known as a medical doctor among the inhabitants. Since many patients came for medical consultations, a tent hospital was hastily set up in the garden of the Hunza House. HAYASHIDA and Mr. KADOTA, Secretary of the Embassy of Japan in Karachi, arrived by air.

31: The day in the Gilgit Oasis broke early by the echos of the hoopoes. It was decided to hire thirty Hunza and thirty Nagar (or Nagir) coolies for the transportation of the baggage through the glacier regions. Reception by the Political Agent of Gilgit in the evening.

June, 1955—

1: Observations about the environments of the Gilgit Oasis.

2: The spare food, fuel and oil were packed, and the preparations for departure were almost completed.

3: Three jeeps transported the baggage as far as Chalt, the terminal place where jeeps could go.

4: After lunch, MATSUSHITA, HUZITA and Mr. I. U. KHAN, left Gilgit for survey along the Indus River by jeep accompanied by three porters and thirty-five coolies. Soon after, IMANISHI, NAKAO, HARADA, HAYASHIDA, Capt. BUTT and Mr. KADOTA also left Gilgit for Hunza by two jeeps. When the jeeps ran about one hour along the Hunza River, the road was closed by snow debris of a previous avalanche, and they had to walk. Coolies carried the baggage on their backs to the rest house in Chalt.

5: Stayed at the rest house. It was pleasant there, except for a swarm of house flies.

for bathing.

June 8. Reached Hunza and received the warm welcome by The Mir of Hunza. The guest house in the Palace was opened for them and they were treated with the local wine, "Hunza pani". The Mir kindly requested The Mir of Nagar to arrange porters for KUSE in Nagar.

9: It was pleasant to stay in the guest house with a wonderful view of the Rakaposhi Range from the window. Cool dry air was really refreshing. A message was delivered from The Mir of Nagar replying that porters could not be arranged in Nagar in advance.

10: Doctor HARADA's free dispensary became very popular also in Hunza. NAKAO went to the Batura Mountain for herborization. (Photo. 25). Main crop was wheat, but buckwheat and millet were also cultivated. Apricots, platanes, populars, and weeping willows were the shadow trees in the oasis.

Nagar Territory

11: Moved from Hunza to Nagar. Crossing a suspension bridge entered the Territory of Nagar. The Oasis of Nagar was green with apricot groves and wheat fields well irrigated with clear water. In front of the Palace were flower wreaths. The Mir of Nagar invited the members for lunch. A few pieces of baggage sent from Chalt did not arrive, because the road was closed due to the afternoon flood.

12: Mr. S. KHAN, the milk brother of The Mir, was elected as an interpreter. He was a tall sturdy boy. In the afternoon The Mir invited the members to archery and spear games and also to a polo game. He himself was a skilled rider in these games.

13: Rest.

14: The members of the field survey in the glacier regions started for Hispar with seventy-four coolies. (Photo. 22). After thirty minutes they crossed the terminal part of the Barpu Glacier which lies below the wheat fields covered by gravel and boulder debris. They marched on the steep path along the Hispar River. Camp for the windy night was set on a riverain level ground.

15: Started from the camp site at 6:20 in the morning. The path along the

Trip to the Hispar and Biafo Glaciers of IMANISHI, NAKAO, HARADA, Capt. G. S. BUTT and Mr. S. KHAN

June 17: Mr. KADOTA left the village alone early in the morning. The others started for the Hispar Glacier with all porters and coolies. After one hour, came to the terminal moraine of the Hispar Glacier. (Photo. 28). It took one hour and forty minutes to cross to the northern bank. There was a good route in the valley with many streamlets of clear water. Many groves of dwarf willow trees and other trees dotted the scenery. Green grass was growing well like in a spring pasture. A camp site was chosen beside a shallow pond, and its stagnant water was used for cooking. Coolies reached the camp with the baggage five hours behind the arrival of sahibs.

18: Proceeded up through the northern abrasion valley of the Hispar Glacier, and crossing the confluence of the Kunyang Lac Glacier, reached Dachigan. Fresh meat of ibex was obtained from yak herdsmen. The altitude of the site was over 4,000 m, and the first symptom of mountain sickness appeared. (Photo. 29).

19: Rained from early morning, and the surrounding scenary was closed by clouds. Stayed in the camp. Leaves of wild onions were collected for Sukiyaki with ibex meat for dinner.

20: Started from the camp site at 7:30 toward the opposite bank of the Glacier through the northern abrasion valley. On the way, met a herd of more than ten ibexes.

21: It snowed rather heavily during the night, and the flowering turf around the camp was entirely covered with snow. Coolies wanted to use leather boots for further travel, but as it was not allowed, they went on strike. In three hours, however, Capt. BUTT dissolved the problem by the method of "divide and rule".

22: From 6:30, continued the march along the Hispar Glacier. Camped on a small patch of level ground.

23: At the start in the morning, coolies asked for special care of tipping. As it was agreed coolies began to move, but slowly. Soon after snow became

lines on the hard white snow. Around 11:00, they stopped the march to avoid wading in wet snow caused by hot sunshine.

June 25: At 11:00, coolies reached the top of the Hispar Glacier. (Photo. 32). Two sahibs and Capt. BUTT used skis, but it only made them late because snow was as hard as ice. Food and fuel were deposited for the return trip. Only thirty coolies were hired on for further travel, and the remaining ones were dismissed. The ski tour down to the Biafo Glacier from the top of the Hispar Pass was very pleasant. But as coolies were late, camped below the Hispar Pass to wait for them.

26: As coolies wanted to sleep one night on the ground after two night travel on snow and ice, they hurried down the Biafo Glacier. At 16:30, arrived at a spot with bare ground where some willow shrubs grew. Camp was set there. Early in the morning, HARADA and Capt. BUTT left the camp for the Hispar deposit to fetch the necessary supplies, but encountered a sudden afternoon flood on the Snow Lake. Mr. S. KHAN and two porters were sent for rescue. At 21:15 they returned with HARADA and Capt. BUTT.

27: Continued to march down the Biafo Glacier through the lateral moraine. There were plenty of green shrubs and primulas. Cuckoos were heard singing. The weather was dark and dull all day, but the camp on a sandy flat was pleasant enough because of good water, a wind-break by a big rock, and plenty wood for fuel.

28: Continued to march as yesterday. The central part of the glacier stream was found flat with hard ice and easy to walk on. But, as it was not possible to reach Askole during the day, camp was set by the side of the glacier. Food was almost consumed, but there were plenty of wild onions around the camp. It rained heavily during the night.

29: The rain stopped early in the morning. Started at 6:50. When the clouds cleared, Mango Gusor stood there. At 14:30 passed the last moraine hill of the Biafo Glacier, and arrived in Askole. Joined with the members who came back from the Indus River trip.

Indus River Trip of MATSUSHITA, HAYASHIDA and Mr. I. U. KHAN

June 6: Marched down the Indus River and reached Sasli, where was the terminal point for the jeep.

7: Geological observations in and around the village. People were busy harvesting wheat.

8: Marched along the Indus River. On the way, a hot spring was found from a rock crevice.

9: Reached as high as 1,600 m on the slope of the Haramoshi Mountain. The view from there was spectacular and wonderful, but it began suddenly to rain. Policemen arrived with thirty-eight coolies from Skardu. Camped in Shengus.

10: Ponies were sent back, and it was decided to travel further to Askole through Istak La and Ganga La, as they said that those places were the only places where "ata" was available in the valley of the Istak River.

11: Rest.

12: The end of the gorge of the Indus River was almost reached, and the valley became wide. Camped in Kiriung, located at a height of 2,500 m. Apricots were not ripe yet and wheat fields were green. Fifty pounds of "ata" were purchased from the villagers.

13: Proceeded up along the Istak River. There were many houses in the verdant valley with walnut and popular trees. There was a polo-ground also. Camped at Karkor.

14: Preparation for crossing Istak La. One goat was purchased as food for all sahibs and porters.

15: Went up the wide and beautiful valley. In every village, plenty of fresh sour-milk was available. After Kurchung entered the conifer forest zone.

16: Reaching the timber line at noon, camped in a birch forest.

17: Started at 6:00 for Istak La, and at 9:15 crossed a pass (alt. 4,500 m) like a big snow saddle. A view of the Haramoshi Mountain was splendid. As there was a big snow cornice, coolies were pulled up by ropes. It began to sleet. Coolies sang Baltit songs loudly to keep warm as they rushed down the snow slope.

18: A short excursion through the Tormik River valley.

19: For crossing the high pass, sixteen coolies were replaced by local ones. Two

June 23: Proceeded to Chokpiong. Two coolies became ill.

24: Land-slides were seen beside the main stream of the Braldu River. As the suspension bridge at Pakore was almost broken, had to camp there.

25: Crossed another suspension bridge nearby. The valley became broader and broader. Camped beside one of the hot springs.

26: Arrived in Askole at last, and camped on a spot in the shade of popular and willow trees.

27: Hunza and Hispar party was scheduled to arrive, but did not.

28: Stayed in Askole.

29: Awaited Hunza and Hispar party arrived, and congratulated for a happy reunion with each other.

Baltoro Excursion of IMANISHI, MATSUSHITA, HARADA, HUZITA, NAKAO, Capt. G. S. BUTT and Mr. I. U. KHAN

30: Rest in Askole.

July, 1955—

1: During the night, a leopard roared and all the dogs in the village seemed to have shrunk up with fears.

2: Preparations.

3: Mr. Salim KHAN and one porter were sent to Skardu to purchase necessary things and food stuffs.

4: Marched to the Baltoro Glacier. Arriving the snout of the Biafo Glacier, the camp was set. Porters began to revolt against sahibs in the evening.

5: Hunza porters refused to make a compromise with sahibs, and they all left the camp early in the morning, and went to Hunza through the Biafo and Hispar Glaciers. Afterwards it was known that one of them fell in a crevasse and was lost. Proceeded up the stream and crossed the Dumordo River by the birch-branch suspension bridge and camped on the gravel of the Biafo Lungma.

6: Continued the march upward along the Biafo Lungma. It was cloudy, and a strong cold wind blew down the river. Lunch at Bardumar. Scattered were many groves of shrubs. *Rosa webbiana* with pink colored flowers was in full

July 10: Stayed in Urdokas. Coolies prepared "ata" cakes for further trip for a few days, because fuel wood was supposed to be short after Urdokas. (Photo. 23).

11: Proceeded on the main glacier of Baltoro, taking the way with boulders on hard ice. Camped beside a row of the huge ice seracs. (Photo. 35).

12: As the weather became better sahibs and coolies marched in high spirits, and reached Concordia at 16:00. The K2, Broad Peak, Gasherbrum and many other high peaks were seen from there. (Photo. 26). Only five coolies reached Concordia.

13: In the morning the sky was perfectly clear and a grand view of the first class high mountains was before the eyes.

14: Returned to Urdokas. IMANISHI and HARADA suffered from diarrhoea.

15: Early in the morning, food arrived from Askole.

16: Went down the Baltoro Glacier and camped on the sands beside the glacier.

17: Arrived at Paiju and camped there.

18: Stayed in Paiju. It was rather cloudy and the wind blew hard.

19: Mr. S. KHAN came for liaison from Skardu. Camped on the sand bank of the Dumordo River.

20: The weather was windy and cold, and it even rained. Food stuffs including one sheep, nine chickens and four dozens of eggs arrived for a big feast.

21: Rain stopped but the path was bad. Mist closed out the scenery. One sahib suffered from diarrhoea.

22: Returned to Askole. The village was thought of by the members who returned from the glacier to be a beautiful summer resort.

23: Field observations around the village.

24: Farewell dinner.

Passing Hispar Pass of MATSUSHITA, HUZITA, HARADA, HAYASHIDA, Capt. G. S. BUTT, Mr. I. U. KHAN.

25: The party consisted of six sahibs, two cooks, and one Nagar porter and seventy-six coolies (21 from Nagar, 7 from Baltit and 48 from Askole). Pro-

to avoid the danger of an afternoon flood.

July 30: Reached the place below the Hispar Pass by noon and camped there. Coolies did not complain though it was very cold to sleep on ice.

31: Left the campsite at 5:00 and reached the end of the Hispar Glacier after the march of more than 20 km.

August, 1955—

1: March on the abrasion valley was very pleasant. The snow seen before was almost gone, and instead, flowers adorned the scene in full bloom.

2: Marched at full speed and reached Dachigan.

3: Coolies walked with their home speed.

4: Arriving the Hispar Village, camped.

5: Camped on the way to Nagar along the Hispar River. Then, coolies, cooks or porters became thieves. Boots, cooking utensils, sugar and anything else were stolen by them.

6: Arrived Nagar at last. Letters from Japan pleased the members, but Capt. BUTT said that the atomosphere in Nagar is not good any more due to the ill willed rumor by the escaped porters and coolies.

7: Stayed in Nagar for rest.

8: The day was a Mohammedan Feast. It was also the first night in the history of Nagar that an electric lamp was lighted by The Mir's own water power plant.

9: Stayed in Nagar.

10: One tent was presented to The Mir.

11: Nagar porters and coolies were all payed.

12: Most of the baggage was sent to Chalt on horseback. Moved from Nagar to Hunza. The Mir of Hunza received them warmly.

13: Rest.

14: IMANISHI and NAKAO came back to Hunza, after a twenty day separated trip.

Skardu, Hunza and Nagar Trip of IMANISHI, and Others

July, 1955—

25: Leading fifteen coolies with the rocks and plant specimens, three sahibs left

July 28: As the food stocks were almost exhausted, had to march without breakfast and lunch. Arrived at Shigar in the evening and camped on the green polo-ground. (Photo. 33).

29: The baggage was sent by coolies to Skardu. Two sahibs and Mr. S. KHAN enjoyed a voyage in "zhakh", skin coracle, to Skardu. (Photo. 36). Visited the Additional Political Agent (APA) to get the permission for air flight to Gilgit. Stayed in a guest house in Skardu.

30: Stayed in Skardu.

31: Dr. Grady L. WEBSTER of Harvard University and Dr. Eugene NASIR of Gordon College, both being the botanists who joined the Harvard University Chogolisa Expedition, were in the same guest house.

August, 1955—

1: Attended a reception given by the Karakoram Mountaineering Club. Valuable informations were obtained from the Club members.

2: Early in the morning, left the guest house in Skardu by jeep and arrived at the airport. One Dakota plane soon landed. But it was known that she would fly back to Rawalpindi, and the second plane would fly to Gilgit. Decided to take the second one, but she did not arrive during the day. Overnighted in an army camp.

3: Waited the arrival of the plane, but she never came.

4~8: Stayed at the Skardu Airport waiting for her.

9: Around noon, one plane landed on the air field, and at last were able to leave a week seclusion at the airport. Arrived at Rawalpindi late in the afternoon.

11: Arrived in Gilgit from Rawalpindi by air and stayed again in Hunza House. The Political Agent of Gilgit invited them for the garden party in the evening.

12: Gilgit–Chalt. Stayed in the rest house in Chalt. The baggage was carried late in the evening under the kind management of Mr. S. KHAN.

13: IMANISHI and NAKAO went on horseback, but Mr. S. KHAN went on foot. Mr. S. KHAN from Nagar was not admitted into the Territory of Hunza. Camped at Maiun.

14: IMANISHI and NAKAO reached Hunza and joined with the members who had come from Askole through the Biafo and Hispar Glaciers.

invited them for tea and dinner.

August 18: NAKAAO went for herborization along the Bualtar Glacier. Huzita went to the Hopar village for a geological survey.

19: NAKAO returned from the Bualtar Glacier.

20: IMANISHI, NAKAO and HUZITA left Nagar on horseback and reached the rest house in Minapin.

21: A forest of *Picea* was seen near the Glacier. (Photo. 38). (MATSUSHITA and others arrived in Gilgit from Hunza.)

22: Stayed in Chalt.

23: Stayed in Nomal.

Back to Karachi

24: All the members of the Karakoram Team returned to Gilgit.

25: It was the last day in Gilgit, and had the farewell dinner with Mr. and Mrs. KEANNY, Political Agent of Gilgit.

26: Flew to Rawalpindi, and parted with Capt. BUTT there.

27: In the morning, met KIHARA and YAMASHITA alighted in the Rawalpindi Airport on the way from Peshawar to Karachi. In the afternoon, left for Lahore on a lorry with all the baggage.

28: Visited the Punjab University, but it was closed because it was Sunday. In the evening, left Lohore by train for Karachi.

29: Arrived at Karachi and joined with the members returned from Afghanistan and Iran.

REUNION AND RETURN

"Sayonara" Karachi

August, 1955—

25~29: All the members except YAMAZAKI, UMESAO and OKAZAKI, returned to

Bank in Karachi in the evening. (Photo. 39).

September, 1955—

1: All the members visited the Prime Minister for farewell greeting at 9:00. KIHARA, IWAMURA, KITAMURA, YAMASHITA, HARADA, NARA, HAYASHIDA and NAKAMURA left Karachi at 14:00 by Air France.

2: KIHARA and others arrived in Tokyo at 22:00. IMANISHI, MATSUSHITA, HUZITA and NAKAO left Karachi at 18:00 by BOAC.

3: IMANISHI and others arrived in Tokyo late in the evening.

Remainders

OKAZAKI stayed in Tehran longer after IWAMURA left there on Aug. 25. After further historical survey along the "Silk Road" in Iran, he returned to Japan at the Yokkaichi Port by the "Nisshomaru", a tanker, on Dec. 15, 1955.

After IWAMURA, OKAZAKI and NAKAMURA left for Iran on August 2, YAMAZAKI and UMESAO remained in the Moghol communities in the Ghorat and Hari-Rud districts. (Photos. 15~21). On Sept. 23, they finally left Herat for Kabul. YAMAZAKI flew to Tehran for further studies on his Moghol materials collected in Afghanistan, while UMESAO started on his way home. UMESAO traveled through Pakistan and India and returned to Tokyo on Oct. 11, 1955.

In the last paragraph, the narrators feel very much depressed to write about the really lamentable death of YAMAZAKI in Tehran in 1956, who always shared the hardships with the members during the expedition. YAMAZAKI joined the expedition as a very important Mongolist who could handle the Mongolian language. According to UMESAO, he was healthy, and was always enthusiastic in pursuing his studies about Moghols in Afghanistan. His pleasing personality established an intimacy with all the Moghol village seniors, who willingly gave all the informations of their knowledge. In Tehran, he continued studies on the Zirni Manuscript (KUSE Vol. VI published in 1961), and during his spare time he studied the Persian language as well.

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many cultivated plants, namely wheats, vegetables, melons, fruit trees, etc. Collecting seeds of those various cultivated plants was also our task. So the scheme of the expedition became wide including Karakoram, Hindukush and Elburz.

We were very eager to observe the wild plants in their habitats and to collect the specimens. Prof. KITAMURA, a well known taxonomist specialized in Compositae, was entrusted with the determination of the Nepalese specimens collected by Dr. NAKAO. At first it was rather difficult for him to identify the plants, being many of them not familiar to him. Later he could manage very well. In the meantime he found that ca. 1,000 plant specimens from Tibet had been preserved in the National Science Museum of Tokyo. These specimens were collected and brought back by a Japanese buddhist priest, E. KAWAGUCHI, who went to Tibet twice, in 1900 and 1914. The collection was made during his second visit. Since KITAMURA was already familiar with Nepalese plants, he could easily identify the specimens from Tibet. He and his coworkers could determine ninety-two species belonging to seven families. sixteen of them were new species. If these specimens had been examined immediately after the collection, twenty of them would have been new species.

Thus our project became bigger than we have thought at the beginning. But the expedition was approved by the Ministry of Education and funds for the traveling were given. Also the Asahi Press promised us to support our exploration, and the Nichi-Ei Shinsha (Japan Scientific Film Cooperation Ltd.) agreed to send two cameramen to take a documentary film of the expedition.

It took more than one year to elaborate our plans, details of our routes, organization of the expedition, etc.. Finally, we have decided to send twelve members, one reporter and two cameramen and to form two teams. One went to Karakoram and the other to Hindukush. Their names and special fields are given here:

Hindukush Team	Karakoram Team
Hitoshi KIHARA, Genetics	Kinji IMANISHI, Anthropology
Siro KITAMURA, Plant Taxonomy	Susumu MATSUSHITA, Geology
Kosuke YAMASHITA, Genetics	Kazuo HUZITA, Geology
Sinobu IWAMURA, History	Sasuke NAKAO, Botany
Tadashi YAMAZAKI, Linguistics	Naohiko HARADA, Medical Science

approved by the Ministry of Education and had to be the first precedent for the following expeditions.

So we endeavored to study an enormous amount of literature. Almost all contributions were made by European scholars. The names of the explorers, for instance, Mark Aurel STEIN, Henning Haslund CHRISTENSEN, RAMSTEDT and many other humanistic scientists, mountaineers and geologists, DESIO, DYRENFURTH, etc., botanists, GRIFFITH, BUNGE, AITCHISON, VAVILOV and others, were mentioned on many occasions at our meetings.

Since the advent of eighteenth century, the eyes of European scientists were directed to the eastern hemisphere. Many visited the Near East and some of them came to Japan. Thus almost all scientific contributions concerning the Asian Continent have been done by western scientists. It was high time for us to look at our neighborhood from our side and to get acquainted with it from our own experience.

Until now we have published seven volumes of our reports including the present one. The series will be completed with the eighth volume, which contains the further reports on the geological, botanical and zoological investigations.

Acknowledgement

We are most grateful to the Ministry of Education and Asahi Press for supplying their financial aid and other helps. Also our thanks are due to the Japanese diplomatic and private institutions stationed in Pakistan, Afghanistan and Iran, which gave us assistance whenever necessary. To Asahi Press we owe also thanks for the financial aid for editing the publications. Further we want to thank our student members of AACK, who helped us greatly with the purchase of equipments and shipment of our traveling baggage. Lastly we want to add that the documentary movie film entitled "Karakoram" produced by Nichi-Ei Shinsha Ltd. created a nationwide sensation. It won several prizes including the Art Festival Prize (Cinema Category) and the Blue Ribbon Award from the Movie Press Club.

Hitoshi KIHARA

CONTENTS

Morphological, physiological, genetical and cytological studies in *Aegilops* and *Triticum* collected from Pakistan, Afghanistan and Iran

H. KIHARA[1], K. YAMASHITA[2] and M. TANAKA[3]

Contents

Introduction

On the basis of genomic and morphological analyses, the genealogical relationships in wheat and *Aegilops* have been established by KIHARA (1924, 1949). It was found that the genus *Triticum* consists of three basic genomes, A, B and D, and our dinkel or bread wheat was originated as an amphidiploid of a hybrid between a species of emmer wheat (AABB) and *Ae. squarrosa* (DD).

As will be described elsewhere, it has been known that *Ae. squarrosa* is distributed in the vast area east of Caucasus, namely Iran, Afghanistan, Pakistan and the neighboring regions of U. S. S. R.

6x wheats have been synthesized from various cross combinations of emmer wheats and *Ae. squarrosa*, among which the one from the *T. persicum* × *Ae. squarrosa* combination resembles exactly the established bread wheat, *T. vulgare* (*aestivum*)[1]. For further studies it was necessary to examine the ecological conditions of the original habitats of those putative ancestral species and to collect more materials from there. KIHARA and YAMASHITA, the senior authors of the present paper, joined the Kyoto University Scientific Expedition (KUSE) to the Karakoram and Hindukush in 1955, of which KIHARA was the leader, and collected many species of *Triticum* and *Aegilops* from Pakistan, Afghanistan and Iran. They started with their exploration tour from Quetta, Pakistan, toward the end of May, and arrived in Kabul on June 7, 1955. KIHARA flew to Tehran on June 25 in advance and made collections around Isfahan and in the Gorgan region, while YAMASHITA made an *Aegilops* hunting trip from Kabul through the Hindukush range and Turkestan to Tehran, Iran (June 23 ~ July 12) driving a jeep along the ancient "Silk Road". They also made together the Azerbajan trip (July 18 ~ July 30). From these trips[2] a great many samples of *Triticum*, *Aegilops* and related genera, wild plants and also seeds of various crops have been collected.

The present paper deals chiefly with morphological, physiological, genetical and cytological studies in *Triticum* and *Aegilops*. A short paper on the morphology and physiology of *Ae. squarrosa* strains was published in a special volume of Preslia (1958) in commemoration of the 85th birthday of Prof. Bohumil NEMEC.

The present investigations have been carried out with the aid of grants from our Ministry of Education, as well as from the Rockefeller Foundation in New York, U. S. A. for which we wish to express our deep gratitude.

We are indebted to Prof. Dr. H. KUCKUCK, "Technische Hochschule", Hannover, Germany, for valuable informations of his experiences in collecting wheat and *Aegilops* in Iran.

We appreciate the help and courtesy given by the officials of the Governments of Pakistan, Afghanistan and Iran, as well as the Embassies of Japan in those countries. Thanks are due to the representatives of the Japanese companies stationed in the countries where we traveled. We are much indebted to Dr. F. A. LILIENFELD, National Institute of Genetics, for her valuable advice in publishing the present data. Thanks are also due to Miss Yoko IWAKAWA, secretary of the Biolo gical Laboratory, Kyoto University, for her assistance in the preparation of the manuscript.

Material and Method

Considering the geographical as well as the ecological conditions of the localities where the materials were collected, the whole area along the route of our trips covering over 6,000 km has been divided into nine regions, namely Quetta region in Pakistan, Kabul, Pul-i-Khumri and Maimana regions in Afghanistan, and Tehran, Isfahan, Gorgan, Pahlavi and Tabriz regions in Iran.

Table 1. Number of strains and habitats of collected *Triticum*

Region	Einkorn		Emmer		Dinkel	
	Strains	Habitats	Strains	Habitats	Strains	Habitats
Pakistan :						
Quetta	0	0	2	1	26	6
Afghanistan :						
Kabul	0	0	0	0	54	39
Pul-i-Khumri	0	0	0	0	2	2
Maimana	0	0	0	0	11	5
Iran :						

Table 2. Number of strains and habitats of collected *Aegilops*

Region	*squarrosa*		*crassa* (4x and 6x)		*cylindrica*		*triuncialis*		*columnaris*	
	Strains	Habs.	Strains	Habs.	Strains	Habs.	Strains	Habs.	Strains	Habs.
Pakistan:										
Quetta	15	13	0	0	0	0	0	0	0	0
Afghanistan:										
Kabul	35	22	9	2	0	0	0	0	0	0
Pul-i-Khumri	31	15	13	7	0	0	14	10	0	0
Maimana	24	15	12	7	0	0	16	11	0	0
Iran:										
Tehran	14	6	5	2	7	3	24	9	17	2
Gorgan	23	15	0	0	0	0	2	2	0	0
Pahlavi	25	13	0	0	3	3	0	0	0	0
Tabriz	9	6	10	10	20	16	18	15	4	2
Isfahan	0	0	0	0	0	0	0	0	0	0
Unknown	3	1	8	1	5	2	29	2	0	0
Total	179	106	57	29	32	24	103	49	21	4

Remarks: *Ae. triaristata* was not involved in the collection.

In every region both *Triticum* and *Aegilops* have been collected, except for Isfahan where not a single species of *Aegilops* was found. The general lists of the collections are given in Tables 1 and 2. The collected *Aegilops* species were: *squarrosa*, *crassa* (4x and 6x), *cylindrica*, *triuncialis*, *columnaris*, *juvenalis* and *umbellulata*. The last two species were supplied by the courtesy of Mr. M. MOJITAHEDI, Department of Agriculture, Tehran, Iran. The collected *Triticum* species were: *durum*, *turgidum*, *vulgare* and *compactum* from the fields and *aegilopoides*, *polonicum*, *orientale*, *spelta* and *sphaerococcum* obtained from various organizations.

Results and Consideration

I. *Aegilops*

koram-Hindukush was organized by Kyoto University in 1955.

a. Collected materials and geographical distribution

Various strains of *Ae. squarrosa* were collected from 106 different habitats, in almost all areas expolored (Table 3). On the basis of their habitats and morphological characteristics they were divided into 179 strains (Table 4). Variety names were determined after EIG (1929). The strains have been maintained at the Research Institute for Agricultural Plants, Faculty of Agriculture, Kyoto University, Kyoto, Japan.

Table 3. List of the collected samples of *Ae. squarrosa* L.

Stock No.[1]	Variety	Locality or source		Growth habit[3]	Collector[4]
2001–3	var. *typica* L.	Quetta,	Pakistan	S	K, Y
2001–6	〃	〃	〃	S	〃
2003–4	var. *anathera* EIG	〃	〃	S	〃
2005–2	〃	〃	〃		〃
2008–1	〃	〃	〃	S	〃
2014–1	var. *typica* L.	〃	〃	S	〃
2015–1	var. *anathera* EIG	Quetta – Chaman,	〃		〃
2016–1	intermediate[2]	Chaman,	〃		〃
2017–2	var. *anathera* EIG	〃	〃	S	〃
2024–7	intermediate	Kandahar – Jaldak,	Afghanistan	S–W	〃
2026–2	var. *typica* L.	〃	〃		〃
2032–1	intermediate	Jaldak,	〃		〃
2033–1	var. *typica* L.	〃	〃		〃
2035–1	〃	〃	〃		〃
2036–1	intermediate	〃	〃		〃
2037–1	var. *typica* L.	Jaldak – Ghazni,	〃	W	〃
2038–1	〃	〃	〃	W	〃

Table 3 (Continued)

2047-1	var. *typica* L.	Kabul,	Afghanistan		K, Y
2049-9	〃	Unknown			Y
2051-1	〃	Kabul – Pul-i-Khumri,	〃		〃
2053-2	〃	Pul-i-Khumri	〃		〃
2054-1	〃	Pul-i-Khumri – Haibak,	〃		〃
2055-3	var. *anathera* EIG	〃	〃		〃
2055-4	intermediate	〃	〃		〃
2057-1	var. *anathera* EIG	〃	〃		〃
2058-3	intermediate	〃	〃		〃
2059-2	var. *typica* L.	〃	〃		〃
2060-3	intermediate	〃	〃		〃
2063-2	var. *typica* L.	〃	〃		〃
2066-9	〃	〃	〃		〃
2067-3	〃	〃	〃		〃
2069-3	〃	〃	〃	S	〃
2072-2	〃	〃	〃		〃
2074-1	〃	〃	〃		〃
2075-1	var. *anathera* EIG	〃	〃		〃
2076-3	intermediate	〃	〃	W	〃
2078-1	var. *typica* L.	Haibak,	〃		〃
2082-3	〃	Andkhui – Maimana,	〃	W-S	〃
2083-2	〃	〃	〃		〃
2083-8	〃	〃	〃		〃
2084-4	〃	〃	〃		〃
2085-1	〃	〃	〃		〃

Table 3 (Continued)

2091-1	var. *typica* L.	Maimana – Laman,	Afghanistan		Y
2092-2	〃	〃	〃		〃
2093-4	intermediate	〃	〃		〃
2095-2	var. *anathera* EIG	〃	〃		〃
2095-9	intermediate	〃	〃		〃
2096-2	var. *typica* L.	〃	〃		〃
2097-2	〃	〃	〃		〃
2099-4	〃	〃	〃	W-S	〃
2101-4	〃	〃	〃		〃
2102-5	〃	〃	〃		〃
2103-2	〃	〃	〃		〃
2104-2	〃	〃	〃	W-S	〃
2105-1	〃	Ghazvin,	Iran		K
2106-2	〃	Karaj (near Tehran),	〃		〃
2107-1	〃	〃	〃	W	〃
2108-4	〃	〃	〃	W	〃
2109-4	〃	〃	〃		〃
2111-7	ssp. *strangulata* EIG	Sari – Behshahr,	〃		〃
2112-3	〃	〃	〃		〃
2115-4	〃	Behshahr – Gorgan,	〃		〃
2118-1	〃	〃	〃		〃
2119-1	〃	Gorgan – Khoshyailagh,	〃		〃
2120-1	〃	〃	〃		〃
2122-3	〃	〃	〃		〃
2123-4	〃	〃	〃		〃
2126-2	var. *typica* L.	〃	〃		〃

Table 3 (Continued)

2134–1	ssp. *strangulata* EIG	Sari – Behshahr,	Iran		K
2135–3	〃	Behshahr,	〃	W	〃
2136–3	〃	〃	〃		〃
2137–1	〃	Babulsar – Sari,	〃		〃
2138–4	〃	〃	〃		〃
2139–1	〃	Babulsar – Chalus,	〃		〃
2139–6	〃	〃	〃		〃
2139–10	var. *typica* L.	〃	〃		〃
2140–2	〃	〃	〃		〃
2141–2	〃	〃	〃		〃
2142–7	〃	Ramsar,	〃		〃
2144–2	var. *meyeri* GRISEB.	〃	〃	W	〃
2145–2	〃	〃	〃		〃
2146–2	var. *typica* L.	Ramsar – Rasht,	〃		〃
2147–1	〃	〃	〃		〃
2148–1	〃	Rasht,	〃		〃
2150–1	〃	Pahlavi,	〃		〃
2152–1	〃	〃	〃		〃
2153–3	〃	〃	〃	W	〃
2154–4	〃	Pahlavi – Astara,	〃		〃
2155–5	var. *meyeri* GRISEB.	〃	〃		〃
2157–2	〃	Astara,	〃		〃
2159–2	var. *typica* L.	〃	〃	W	〃
2162–6	intermediate	Ardabil,	〃		K, Y
2163–5	〃	Ardabil – Surab,	〃		〃

Table 3 (Continued)

2174-1	var. *typica* L.	Khoy – Tabriz,	Iran	K
2179-2	〃	〃	〃	〃
2175-2	〃	Mixed in chicken feed, in Tabriz, Iran		Y
2176-8	〃	〃		〃
2180	intermediate	Chalus, Iran, given by the courtesy of Mr. H. KAKIZAKI		
2181	〃	〃		
2182	〃	〃		

2) intermediate: intermediate type between var. *typica* and var. *anathera*.
3) S=Spring, W=Winter.
4) K: H. KIHARA, Y: K. YAMASHITA.

Table 4. Number of strains and habitats of collected *Ae. squarrosa*

Region	Total		*typica*[3]		*meyeri*		*strangulata*	
	Habitats	Strains	Habitats	Strains	Habitats	Strains	Habitats	Strains
Pakistan :								
Qutta	13	15	13	15	0	0	0	0
Afghanistan :								
Kabul	22	35	22	35	0	0	0	0
Pul-i-Khumri	15	31	15	31	0	0	0	0
Maimana	15	24	15	24	0	0	0	0
Iran :								
Tehran	6	14	6	14	0	0	0	0
Gorgan	15	23	1[2]	2	0	0	15	21
Pahlavi	13	25	9	18	4	7	0	0
Tabriz	6	9	6	9	0	0	0	0

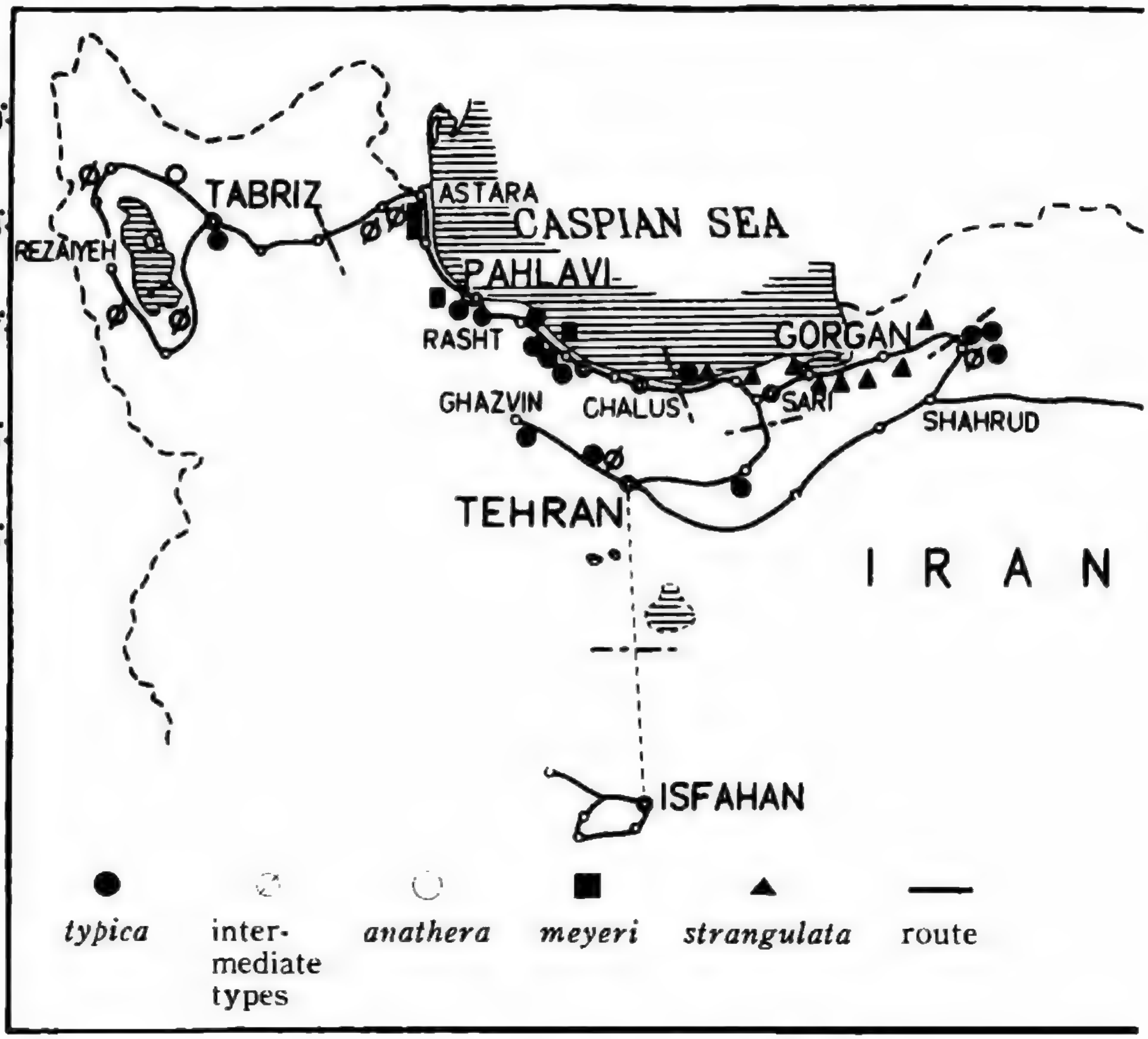
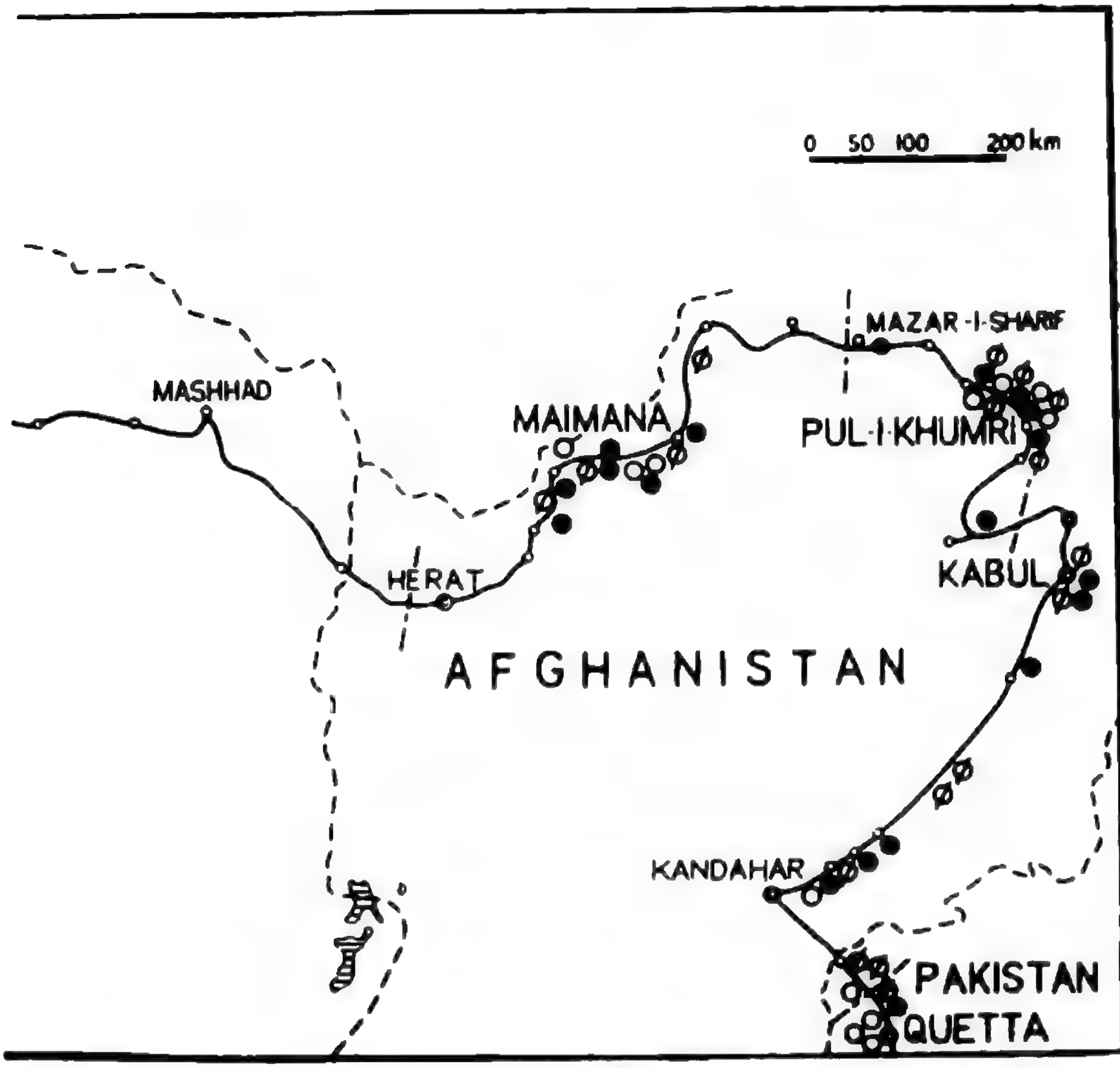


Fig. 1. Map showing the localities of



Ae. squarrosa along the route of KUSE 1955

Fig. 1 shows a map of the localities of var. *typica*, intermediate forms, var. *anathera*, var. *meyeri* and ssp. *strangulata* along the expedition routes. As it is difficult to plot all the habitats of 176 collected strains on the map, they are reduced in number proportionally to the numbers of the collected strains.

Ae. squarrosa usually occurred in wheat fields or along field borders. In one habitat (Fig. 2) between Ghazni and Kabul, Afghanistan, *Ae. squarrosa* and *Secale* grew mixed in a wheat field; head samples from one meter squares consisted of 153 wheat, 27 *Ae. squarrosa* and 45 *Secale* heads. *Ae. squarrosa* was found only once in a barley field, which was located near a wheat field. *Ae. squarrosa* grew wild in many places. It was found also in the gardens surrounded

Fig. 3. Association of *Ae. squarrosa* with *Ae. triuncialis*, Pul-i-Khumri – Haibak, Afghanistan (June 27, 1955)

YAMASHITA returned to Karachi, Pakistan and went to Rawalpindi, where they visited the herbarium of the Gordon College. They found there two specimens of *Ae. squarrosa*, both being *typica*. One was collected from Kaghan (N. W. F. P.) and the other from Sambal Nallay, Srinagar, both representing probably the easternmost habitats in the distribution of *Aegilops* species.

b. Morphological characters

Ae. squarrosa differs from other diploid species of *Aegilops* by its barrel-type disarticulation and truncate sterile glumes. After EIG (1929) this species is classified into two subspecies, namely ssp. *eu-squarrosa* EIG and ssp. *strangulata* EIG.

Ssp. *eu-squarrosa* contains three varieties, *typica*, *meyeri* and *anathera*. They are described as follows:

Table 5. Number of strains of *Ae. squarrosa* collected in wheat fields and other places

Habitat	Variety						Total
	typica	Inter-mediates	*anathera*	*meyeri*	*stran-gulata*	*strangulata* + *typica*[1)]	
Wheat fields with:							
T. vulgare	16	11	4	0	13	3	47
T. durum	0	0	0	0	1	0	1
Sum	16	11	4	0	14	3	48(59%)
Other places:	9	13	3	7	1	0	33(41%)
Total	25	24	7	7	15	3	81

1) Mixed population of *strangulata* and *typica*.

Table 6. Number of seeds of wheat and *Ae. squarrosa* found in chicken feed in Iran

Source	Wheat grains	*Ae. squarrosa* (spikelets)	Mixtures
Tabriz	8441[1)]	31	*Ae. cylindrica*, *Ae. crassa* *Ae. triuncialis*, barley, etc.

Var. ***meyeri*** GRISEB.: Ear is very slender and short. Number of spikelets anges from four to eight. Awned except for the two lowest spikelets.

Var. ***anathera*** EIG: All spikelets except two apical ones are awnless.

It seems that awnlessness (***anathera***) is associated with thin and short ears nd awnedness with thick and long ears, but there are many exceptions, ***e.g.*** ***nathera***-type with thick and short ears.

Ssp. ***strangulata*** EIG is characterized by its short and beaded ears. The

width of sterile glume usually exceeds the length. Grains are round. Morphologically there is no apparent variation in this group.

Fig. 5 shows different types of ears found in *Ae. squarrosa*.

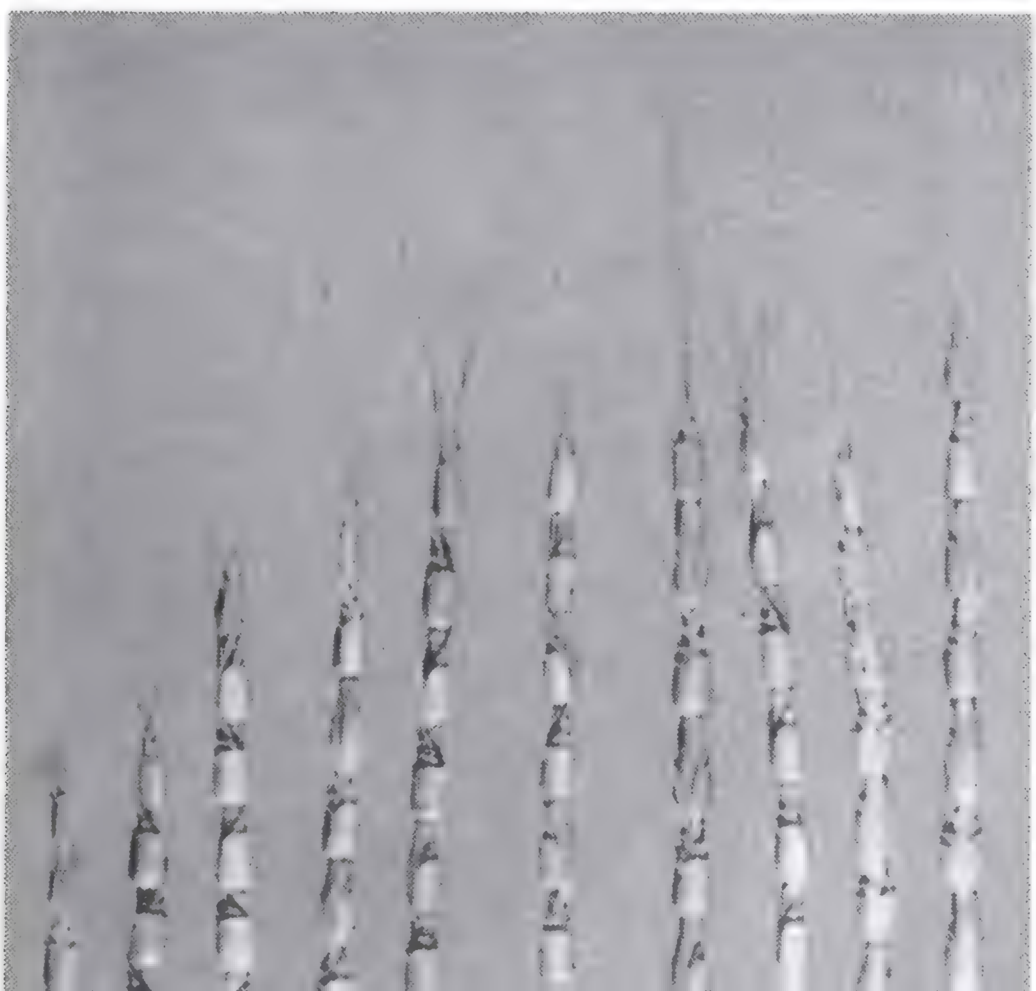
(i) Varietal relations

As mentioned above, three varieties are known in ssp. ***eu-squarrosa***. Vars. ***typica*** and ***anathera*** and their intermediate types were found in the whole area.

It seems that there are at least three allelomorphic pairs among ssp. ***eu-squarrosa***, namely: long vs. short ears, thick vs. thin spikelets and awned vs. awnless or short awned outer glumes. The first alternatives, ***i.e.*** long ears, thick spikelets and awned glumes characterize var. ***typica***, while the other alternatives are found in var. ***anathera***. There are also various recombinants, for example

Table 7. Width/length ratio of sterile glume in *Ae. squarrosa* from Iran

Stock No.	Locality	Variety	Width/length ratio of sterile glume
2107	Tehran	true *typica*	0.75
2129	Khoshyailagh	*typica*	0.92
2135	Behshahr	true *strangulata*	1.18
2139 – 1	Babulsar	*strangulata*	1.04
–10	〃	*typica*	0.89
2140	〃	true *typica*	0.73
2141	〃	〃	0.72
2144	Ramsar	*meyeri*	0.67



an awned type with thin and short spikes like var. ***meyeri***.

Var. ***meyeri*** was localized in the Pahlavi region and ssp. ***strangulata*** was found only in the Gorgan region, but not in other regions. Occasionally intermediate types between ssp. ***strangulata*** and var. ***typica*** occurred (Fig. 6). These types differed markedly in the width and length of sterile glumes.

In various strains from Iran, the width/length ratio of sterile glume was examined and the figures are listed in Table 7. No. 2107 from Tehran in the Tehran region and Nos. 2140 and 2141 from Babulsar in the Pahlavi region are thought to be ***typica*** showing the ratios 0.75, 0.73 and 0.72 respectively, and No. 2135 from Behshahr in the Gorgan region with the ratio 1.18 to be ssp. ***strangulata*** (Fig. 7), while, the varieties from the border areas between the above three regions gave intermediate ratios, namely 0.92 for ***typica*** from Khoshyailagh (No. 2129), 1.04 for ***strangulata*** from Babulsar (No. 2139-1) and 0.89 for ***typica*** also from Babulsar (No. 2139-10). These figures suggest that the variation is due to hybridization among the varieties of the neighboring regions.

No. 2144 ***meyeri*** gave the ratio 0.67.

(ii) Plant height and tillering habit

The materials were divided on the one hand into four classes according to plant height, namely less than 50, 50~65, 65~80 and over 80 cm, and on the other hand into four categories according to tillering habit, namely, procumbent, semi-procumbent, semi-erect and erect. The distribution of these characteristics is shown in Table 8.

It is noteworthy that many tall plants were found in the Gorgan region, all of them belonging to ssp. ***strangulata***. Three tall ***typica***-strains with upright

Table 8. Variation in plant heights and tillering habits

Region	Plant height (cm)				Tillering habit			
	~50	50~65	65~80	80~	Procumbent	Semi-procum.	Semi-erect	Erect
Quetta	4	4	1	0	0	0	9	0
Kabul	3	11	18	0	0	1	31	0
Pul-i-Khumri	4	27	1	0	0	7	25	0

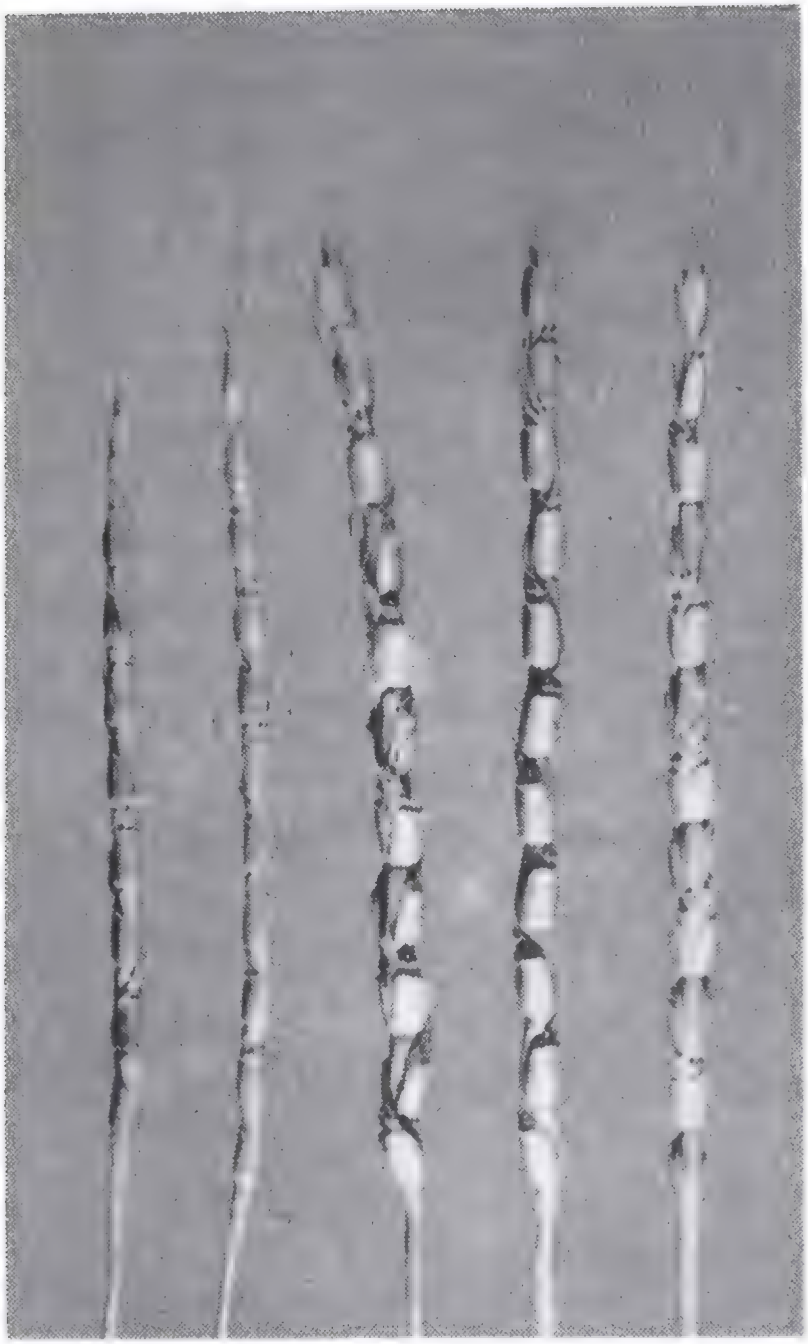

a b c d e

Fig. 8. Ears of *Ae. squarrosa* var. *typica* collected in the Tehran region, Iran

a. No. 2105-1 } normal, c. No. 2106-1 } giant
b. No. 2108-4 d. No. 2130-1
e. No. 2131-3

tillers were found in the Tehran region (Fig. 8). They showed the standing habit even in young seedling stage. Procumbent habit was exhibited only by strains

mixed with waxy, but in two habitats in Khoshyailagh and Karaj, Iran, mixed populations were found (Fig. 9). Hence it can be concluded that the waxy character in *Ae. squarrosa* is distributed, in a very restricted area, around the Elburz Mountains. As has been so far observed all the plants with waxy character had zigzag ears, but the analyses concerning this correlation have not yet been completed.

Purple seedlings are of common occurrence in *Ae. squarrosa*. However,

Table 9. Ten strains with waxy character in *Ae. squarrosa* collected in Iran

Stock No.	Locality	Variety
2106-2	Karaj (Suburbs of Tehran)	var. *typica*
2107-1	〃 〃	〃
2130-3	Khoshyailagh	intermediate type*
2132-9	Firuzkuh	var. *typica*
2162-6	Ardabil	intermediate type*
2163-5	Ardabil – Surab	〃
2172-3	Khoy	〃
2180	Near Chalus	〃
2181	〃	〃
2182	〃	〃

* Intermediate type between var. *typica* and var. *anathera*.

strains with green seedlings (a recessive character) were found mixed in the materials obtained in two isolated regions, Tabriz in Iran and Maimana in Afghanistan (Table 10, Fig. 10). Namely, green and purple seedlings were found in six populations from 15 habitats in the Maimana region, and in two populations from six habitats in the Tehran region. Only a population from the Maimana region was pure green.

Table 10. Distribution of seedling colors in *Ae. squarrsoa* in two regions

Region	Habitats	Mixed populations of green and purple seedlings	Population of green seedlings
Maimana, Afghanistan	15	6	1
Tabriz, Iran	6	2	0

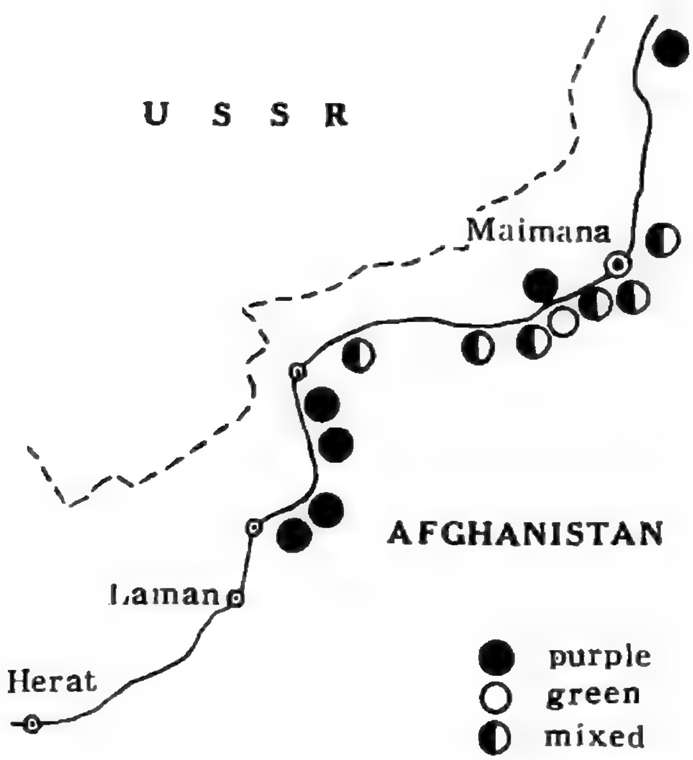


Fig. 10. Geographical distribution of purple- and green-seedling colors in *Ae. squarrosa* in the Maimana region, Afghanistan

Table 11. Distribution of ear colors in *Ae. squarrosa*

Region	Black	Purplish-brown	Brown	Yellowish-brown	Yellow
Quetta	7	0	0	0	0
Kabul	7	10	0	0	0
Pul-i-Khumri	0	10	0	7	1*
Maimana	2	13	7	1	2*
Tehran	10	0	1	0	0
Gorgan	11	0	0	0	0
Pahlavi	13	0	2	0	0
Tabriz	3	0	5	0	3*
Total	53	33	15	8	6*

* Stock Nos. of the strains with yellow ears are Nos. 2053–2, 2083–8, 2087–6, 2167–2, 2168–1 and 2170–1.

some strains from two neighboring regions, Tehran and Pahlavi, but not from other regions.

c. Physiological characters

Differentiation in physiological characters was also observed among strains collected from Pakistan, Afghanistan and Iran.

(i) Shooting date

Early, intermediate and late shooting strains were found. There was a marked tendency to late shooting in the materials from the regions of higher

Table 12. Frequency of strains with various shooting dates in *Ae. squarrosa* obtained from eight regions

Region	Shooting date observed in Kyoto, 1956								
	~5/V	~10/V	~15/V	~20/V	~25/V	~31/V	~5/VI	~10/VI	~15/VI
Pakistan:									
Quetta		5	3	1					
Afghanistan:									
Kabul	1	5	8	7	7	2	1		

latitude or in the western regions, namely Tehran, Gorgan, Pahlavi and Tabriz, while early shooting types were found more often among plants of lower latitudes or in the eastern regions, namely Quetta, Pul-i-Khumri and Maimana. But the strains collected in higher altitude from Jaldak to Kabul were mostly of the late shooting type (Table 12).

(ii) Seed-fertility

There was no significant difference in the seed-fertilities between plants cultivated in Kyoto and those grown under wild conditions in respective localities. This may indicate that the collected strains of *Ae. squarrosa* are adaptable to the climate of Kyoto. This was also ascertained from the fact that those escaped grew wild around the experiment field in Kyoto. The adaptation may be ascribed to the fact that the flowers of this species are almost clistogamous which is favorable for seed setting even in wet weather. Since we knew that any grasses which cover the sand dune of Tottri on Japan Sea are serionsly wanted, we planted various species of *Aegilops*, including *squarrosa*, *triuncialis*, *umbellulata*, *cylindrica*, etc. and left them in free propagation in the grounds of the Sand Dune Laboratory, Tottori University, Tottori, Japan. The expriment was begun in 1961. By now *Ae. squarrosa* has formed an association of a good size.

(iii) Growing habit

Winter-habit prevails in the wild types of *Triticum* and *Aegilops*, especially in the diploid species. Therefore it may be assumed that this is an ancestral character.

Thirty-one strains which were obtained from different regions have been studied for their growing habit in the experiment field in Kyoto. Seven spring-types

Table 13. Distribution of winter-, intermediate- and spring-types in *Ae. squarrosa*

Region	Winter-types	Intermediate-types	Spring-types	Total
Pakistan :				
Quetta	0	1	4	5
Afghanistan :				
Kabul	3	3	1	7

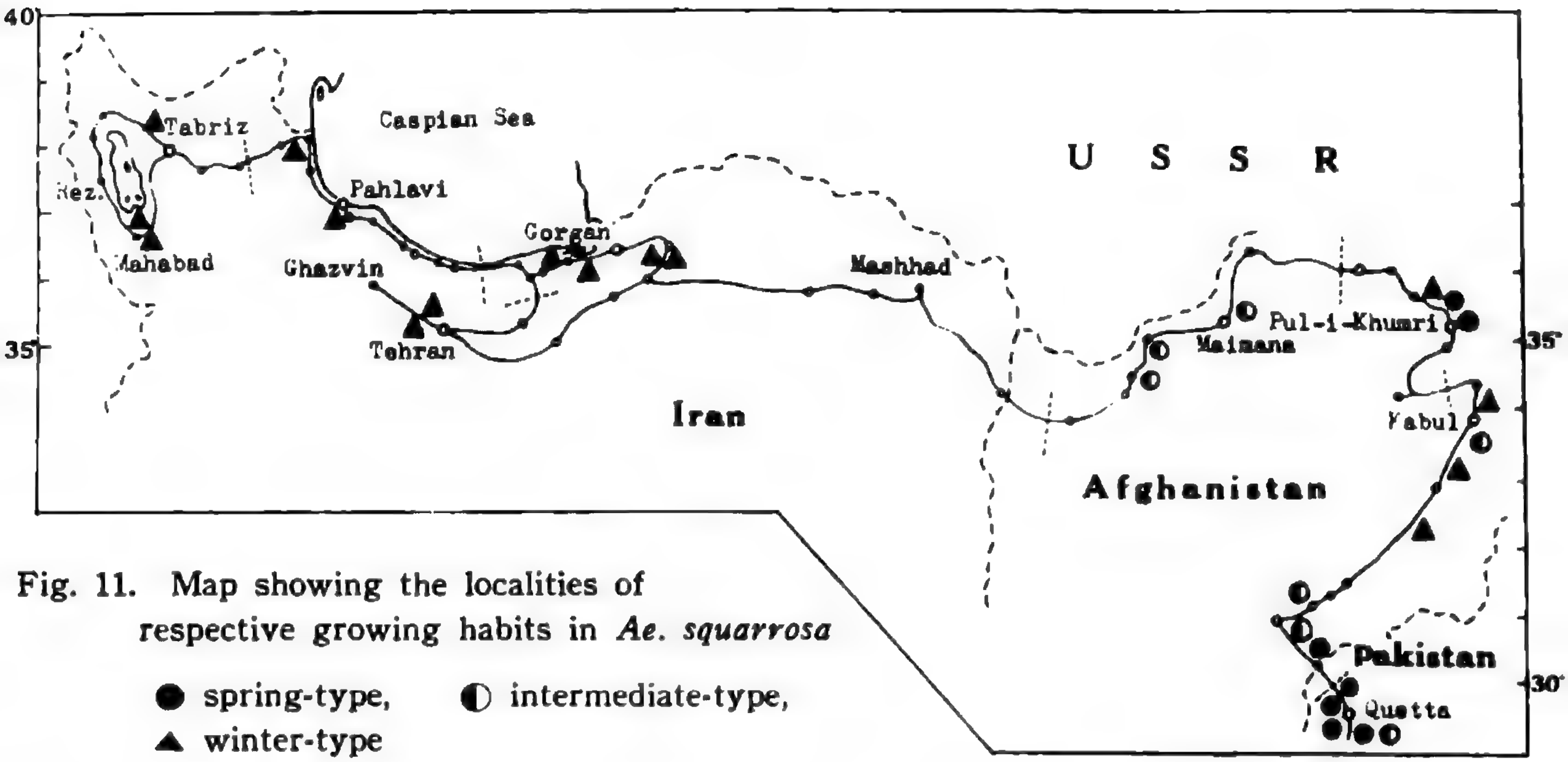


Fig. 11. Map showing the localities of respective growing habits in *Ae. squarrosa*

● spring-type, ◐ intermediate-type, ▲ winter-type

and seven intermediate-types were found in *Ae. squarrosa* from four regions, Quetta, Kabul, Pul-i-Khumri and Maimana (Table 13, Fig. 11). Namely, among five strains from the Quetta region, four strains were of spring-type and one strain was of intermediate-type, while three strains from the Kabul region and one strain from the Pul-i-Khumri region were of the winter-type.

From all other regions in Iran only winter-types were found.

(iv) Resistance to rusts

N. Hiratsuka, Faculty of Agriculture, Tokyo University of Education, Tokyo, Japan), tested the seedling resistance of 136 strains of *Ae. squarrosa* to uredospres of yellow rust, *Puccinia striiformis* Westendorf (*P. glumarum* Eriksson *et* Henning), brown rust, *P. recondita* Roberge *et* Desm. f. sp. *tritici* and black rust, *P. graminis* Pers. f. sp. *tritici* (Table 14). He divided the types of susceptibility to rusts into five groups, A, B, C, D and E. The relationship of susceptibility types to various rusts are summarized as follows.

	A-group	B-group	C-group	D-group	E-group

Table 14. Susceptibility of various strains or varieties of *Ae. squarrosa* to yellow rust (*Puccinia striiformis*), brown rust (*P. recondita* f. sp. *tritici*) and black rust (*P. graminis* f. sp. *tritici*) (HIRATSUKA 1959)

Variety	Stock No. (Locality or source)	*Puccinia striiformis* (*P. glumarum*)	*Puccinia recondita* f. sp. *tritici* 21B	*Puccinia graminis* f. sp. *tritici* 21	Group
	2001 (Quetta, Pakistan)	S (4)	S (3)	S (3-4)	A
	2002 〃 〃	S (3-4)	S (3)	S (4)	A
	2014 〃 〃	S (4)	S (3-4)	S (3-4)	A
	2026 (Kandahar – Jaldak, Afghanistan)	S (4)	S (3-4)	S (3)	A
	2027 (Kabul, 〃)	S (3-4)	S (3)	S (3-4)	A
	2029 〃 〃	S (4)	S (3)	S (3-4)	A
	2030 〃 〃	S (3-4)	S (3)	S (3)	A
	2031 〃 〃	S (4)	S (3)	S (3-4)	A
	2033 (Jaldak, 〃	S (4)	S (3-4)	S (3)	A
var. *typica*	2035 〃 〃	S (4)	S (3-4)	S (3-4)	A
	2037 (Jaldak – Ghazni, 〃)	S (3-4)	S (3)	S (3)	A
	2038 〃 〃	S (3-4)	S (3)	S (3-4)	A
	2040 (Ghazni, 〃)	S (4)	S (3-4)	S (3)	A
	2041 (Kabul, 〃)	S (4)	S (3)	S (3-4)	A
	2042 〃 〃	S (4)	S (3)	S (3-4)	A
	2043 〃 〃	S (3-4)	S (3)	S (3-4)	A
	2045 〃 〃	S (3)	S (3-4)	S (3-4)	A
	2046 〃 〃	S (3)	S (3-4)	S (3)	A
	2047 〃 〃	S (4)	S (3-4)	S (3-4)	A

F.N.: S=Susceptible (3 or 4), MR=Moderately resistant (2), R=Resistant (0 or 1).
Group A=Yellow rust (S)-brown rust (S)-black rust (S); Yellow rust (S)-brown rust (S)-black rust (MR-S).

Table 14. (Continued)

	2048 (Kabul, Afghanistan)	S (4)	S (3)	S (3-4)	A
	2049 (Unknown)	S (4)	S (3)	S (3-4)	A
	2050 〃	S (4)	S (3)	S (3-4)	A
	2051 (Kabul – Pul-i-Khumri, Afghanistan)	S (4)	S (3-4)	S (3)	A
	2052 (Pul-i-Khumri, 〃)	S (4)	S (4)	S (3)	A
	2053 (Pul-i-Khumri – Haibak, 〃)	S (3-4)	S (3)	S (3-4)	A
	2054 〃 〃	S (3)	S (3)	S (3-4)	A
	2056 〃 〃	S (4)	S (3)	S (3-4)	A
	2059 〃 〃	S (4)	S (3-4)	S (3-4)	A
	2063 〃 〃	S (4)	S (3-4)	S (3-4)	A
	2065 〃 〃	S (4)	S (3-4)	S (3-4)	A
	2066 〃 〃	S (3-4)	S (3)	S (3-4)	A
	2067 〃 〃	S (4)	S (3-4)	S (3-4)	A
	2068 〃 〃	S (3)	S (3-4)	S (3-4)	A
	2069 〃 〃	S (4)	S (3-4)	S (3-4)	A
	2071 〃 〃	S (4)	S (3-4)	S (3-4)	A
var. *typica*	2072 〃 〃	S (4)	S (3-4)	S (3-4)	A
	2073 〃 〃	S (4)	S (3)	S (3-4)	A
	2074 〃 〃	S (3-4)	S (3-4)	S (3-4)	A
	2079 〃 〃	MR-S (2-3)	S (3-4)	S (3-4)	E
	2081 (Unknown)	S (4)	S (3-4)	S (3)	A
	2082 (Andkhui – Maimana, Afghanistan)	S (3-4)	S (3-4)	S (3-4)	A
	2083 〃 〃	S (4)	S (3)	S (3-4)	A
	2084 〃 〃	S (4)	S (3-4)	S (3-4)	A
	2085 〃 〃	S (4)	S (3-4)	S (3)	A
	2086 〃 〃	S (4)	S (3-4)	S (3-4)	A

Table 14. (Continued)

	2097 (Maimana – Laman, Afghanistan)	S (4)	S (3–4)	S (3–4)	A
	2099 〃 〃	S (4)	S (4)	S (3–4)	A
	2101 〃 〃	S (4)	S (3–4)	S (3)	A
	2102 〃 〃	S (4)	S (3–4)	S (3–4)	A
	2103 〃 〃	S (4)	S (3–4)	S (3)	A
	2104 〃 〃	S (4)	S (3–4)	S (3–4)	A
	2105 (Ghazvin, Iran)	S (3–4)	S (3)	S (3–4)	A
	2106 (Karaj, Suburbs of Tehran, 〃)	S (4)	S (3–4)	S (4)	A
	2107 〃 〃	S (3–4)	S (3–4)	S (4)	A
	2108 〃 〃	S (4)	S (3–4)	S (3)	A
	2109 〃 〃	S (4)	S (3–4)	S (4)	A
	2126 (Gorgan – Khoshyailagh, 〃)	S (4)	R (0)	S (3–4)	B
	2128 〃 〃	S (3)	R (0)	S (3)	B
	2129 (Khoshyailagh, 〃)	S (3–4)	S (4)	S (3)	A
	2131 (Firuzkuh, 〃)	S (3–4)	S (3)	R–MR (1–2)	C
	2132 〃 〃	S (3)	S (3–4)	S (3)	A
var. *typica*	2141 (Babulsar – Chalus, 〃)	S (4)	S (3–4)	MR (2)	C
	2142 (Ramsar, 〃)	S (4)	S (3)	R–MR (0–2)	C
	2143 〃 〃	S (4)	R (0–1)	S (4)	B
	2146 (Ramsar – Rasht, 〃)	S (3–4)	S (3–4)	R–MR (0–2)	C
	2147 〃 〃	S (3–4)	S (3–4)	R–MR (0–2)	C
	2148 (Rasht, 〃)	S (4)	S (3–4)	R–MR (0–2)	C
	2150 (Pahlavi, 〃)	S (4)	S (3–4)	S (3)	A
	2151 〃 〃	S (4)	S (4)	S (3–4)	A
	2152 〃 〃	S (4)	S (3–4)	S (4)	A

Table 14. (Continued)

var. *typica*	2170 (Rezaiyeh – Khoy, 〃)	S (4)	S (3-4)	S (3-4)	A
	2174 (Khoy – Tabriz, 〃)	S (4)	S (3-4)	S (3-4)	A
	2175 (Tabriz, 〃) (Mixed in chicken feed)	MR-S (2-3)	R (0-1)	S (3)	B
	2176 〃 〃	S (4)	S (4)	S (4)	A
var. *anathera*	2003 (Quetta, Pakistan)	S (3-4)	S (3-4)	S (3)	A
	2005 〃 〃	S (4)	S (3)	S (3)	A
	2008 〃 〃	S (4)	S (3)	S (4)	A
	2015 (Quetta – Chaman, 〃)	S (4)	S (3-4)	S (4)	A
	2017 (Chaman, 〃)	S (3-4)	S (3)	S (4)	A
	2055 (Pul-i-Khumri – Haibak, Afghanistan)	S (4)	S (3)	S (4)	A
	2057 〃 〃	S (4)	S (3)	S (3-4)	A
	2064 (Pul-i-Khumri, 〃)	S (4)	S (3-4)	S (3-4)	A
	2075 (Pul-i-Khumri – Haibak, 〃)	S (4)	S (3-4)	S (3)	A
	2094 (Maimana – Laman, 〃)	S (4)	S (3)	S (3)	A
	2127 (Gorgan – Khoshyailagh, Iran)	S (4)	R (0)	S (3-4)	B
ssp. *strangulata*	2111 (Sari–Behshahr, Iran)	S (3-4)	R (0)	R–MR (0-2)	D
	2112 〃 〃	S (3)	R (0-1)	S (3)	B
	2115 (Behshahr – Gorgan, 〃)	S (3-4)	R–MR (0-2)	R–MR (0-2)	D
	2116 〃 〃	S (3-4)	S (3)	S (3)	A
	2118 〃 〃	S (4)	R–MR (0-2)	S (3-4)	B
	2119 (Gorgan – Khoshyailagh, 〃)	S (4)	S (3)	MR (2)	C
	2120 〃 〃	S (3-4)	S (3-4)	MR (2)	C
	2122 〃 〃	S (4)	S (4)	S (3-4)	A
	2123 〃 〃	S (4)	S (3)	R–MR (0-2)	C
	2133 (Sari – Behshahr, 〃)	S (3-4)	MR–S (2-3)	R–MR (0-2)	C

Table 14. (Continued)

var. *meyeri*	2144 (Ramsar, Iran)	S (4)	R (0-1)	R (0-1)	D
	2145 〃 〃	S (3-4)	S (3-4)	R-MR (0-2)	C
	2155 (Pahlavi - Astara, 〃)	S (4)	S (4)	R-MR (0-2)	C
	2157 (Astara, 〃)	S (4)	R (0)	R-MR (0-2)	D
intermediate between var. *typica* and var. *anathera*	2016 (Chaman, Pakistan)	S (3-4)	S (3-4)	S (3)	A
	2024 (Kandahar - Jaldak, Afghanistan)	S (4)	S (3-4)	S (3)	A
	2032 (Jaldak, 〃)	S (4)	S (3-4)	S (3)	A
	2036 〃 〃	S (4)	S (3)	S (3-4)	A
	2058 (Pul-i-Khumri - Haibak, 〃)	S (4)	S (3)	S (3-4)	A
	2060 〃 〃	S (4)	S (3)	S (3-4)	A
	2076 〃 〃	S (4)	S (3-4)	S (3-4)	A
	2088 (Maimana - Laman, 〃)	S (4)	S (3-4)	S (3-4)	A
	2093 〃 〃	S (4)	S (3-4)	S (3-4)	A
	2095 〃 〃	S (4)	S (3-4)	S (3-4)	A
	2130 (Khoshyailagh, Iran)	S (3-4)	S (3-4)	S (3)	A
	2162 (Ardabil, 〃)	S (4)	S (4)	R-MR (0-2)	C
	2163 (Ardabil - Surab, 〃)	S (4)	S (4)	R-MR (0-2)	C
	2171 (Rezaiyeh - Khoy, 〃)	S (4)	S (3-4)	S (3-4)	A
	2173 (Khoy - Tabriz, 〃)	S (3-4)	S (3-4)	S (3-4)	A
intermediate between var. *typica* and ssp. *strangulata*	2139a (Babulsar - Chalus, Iran)	S (4)	S (3)	MR (2)	C
	2139b 〃 〃	S (4)	MR (2)	R-MR (0-2)	D
	2139c 〃 〃	S (4)	S (3-4)	MR (2)	C

According to his experimental data, almost all strains of *Ae. squarrosa*, var. *typica*, var. *anathera* and the intermediate type, are susceptible to all three rusts, while all strains of var. *meyeri* and most of ssp. *strangulata* are resistant to yellow rust.

Namely, as shown in Table 15, all strains of var. *meyeri* were resistant to the brown and black rusts, being of C- or D-type resistance, 11 out of 16 strains of ssp. *strangulata* were also resistant to the same rusts.

Table 15. Susceptibility of *Ae. squarrosa* to rusts

Variety	Susceptibility					Total
	A-group	B-group	C-group	D-group	E-group	
typica	73(83.9%)	5(5.7%)	7(8.0%)	1(1.2%)	1(1.2%)	87
anathera	10(90.9%)	1(9.1%)	0	0	0	11
intermediate type between *typica* and *anathera*	13(86.9%)	0	2(13.3%)	0	0	15
strangulata	3(18.8%)	2(12.5%)	9(56.2%)	2(12.5%)	0	16
meyeri	0	0	2(50.0%)	2(50.0%)	0	4
intermediate type between *typica* and *strangulata*	0	0	2(66.6%)	1(33.4%)	0	3
Total	99	8	22	6	1	136

However, a few strains of var. *typica* and the intermediate type showed indications of C- or D-type resistance. The types of susceptibility to various rusts of a number or strains and varieties of *Ae. squarrosa* from eight regions are summarized in Table 16 from the results of Table 14. The majority of the strains with C- or D-type resistance were collected in the Gorgan and Pahlavi regions. It is interesting that var. *typica* from the Pahlavi region is resistant, though from other regions it is susceptible. Namely among the 13 strains of var. *typica*

Table 16. Frequency of *Ae. squarrosa* strains and varieties in eight regions, with respect to susceptibility to rusts (HIRATSUKA 1959)

Region	Variety	Susceptibility					Total
		A-group	B-group	C-group	D-group	E-group	
Quetta	*typica*	3	0	0	0	0	7
	anathera	4	0	0	0	0	
Kabul	*typica*	20	0	0	0	0	25
	anathera	1	0	0	0	0	
	intermediate type[1]	4	0	0	0	0	
Pul-i-Khumri	*typica*	16	0	0	0	1	24
	anathera	4	0	0	0	0	
	intermediate type[1]	3	0	0	0	0	
Maimana	*typica*	17	0	0	0	0	21
	anathera	1	0	0	0	0	
	intermediate type[1]	3	0	0	0	0	
Tehran	*typica*	7	2	1	0	0	12
	anathera	0	0	0	0	0	
	intermediate type[1]	1	1	0	0	0	
Gorgan	*strangulata*	3	2	9	2	0	19
	intermediate type[2]	0	0	2	1	0	
Pahlavi	*typica*	4	2	6	1	0	19
	meyeri	0	0	2	2	0	
	intermediate type[1]	0	0	2	0	0	
Tabriz	*typica*	6	1	0	0	0	9
	intermediate type[1]	2	0	0	0	0	
	Total	99	8	22	6	1	136

1) Intermediate type between var. *typica* and var. *anathera*.
2) Intermediate type between var. *typica* and ssp. *strangulata*.

Table 17. Segregation of resistance vs. susceptibility in the varietal crosses in *Ae. squarrosa* (HIRATSUKA 1957)

Parent and cross combination		*P. recondita* f. sp. *tritici* 21B		*P. graminis* f. sp. *tritici* 21	
var. *meyeri* (No. 2144-1)		R		R-MR	
var. *typica* (No. 1)*		MR-S		S	
var. *typica* (No. 2107-4)		S		S	
var. *meyeri* (No. 2144-1) × var. *typica* (No. 2107-4)	F_1	R		R	
	F_2	R (23)	S (3)	R (18)	S (7)
var. *meyeri* (No. 2144-1) × var. *typica* (No. 1)*	F_1	R		R	
	F_2	R (16)	S (5)	R (18)	S (4)

S: Susceptible MR: Moderately resistant R: Resistant.
* Stain from the old collection of Kyoto University.

d. Inter-regional hybrids

Fertility, chromosome conjugation, morphological and physiological characters of F_1 hybrids among the strains obtained from different regions were observed. The characteristics and the seed-fertilities of the strains used in the crosses are given in Table 18.

(i) Cytological observations

Using eight representative strains from eight regions 24 different hybrids out of 56 possible cross combinations were obtained (Figs. 12, 13). So far observed no peculiarities were found. In the meiosis of PMC's in the parental strains as well as in the hybrids, seven bivalents were normally found and the meiotic divisions were found to proceed regularly. Pollen-fertility was examined in all hybrids, the results are given in Table 19. Pollen-fertility of F_1 was usually slightly lower than that of the parents, approximatly 80 to 99%, in one exceptional case 72%. Seed-fertility was higher than 80% in most cases. The lowest one was as low as 46%. The relationships in seed-fertility are illustrated in Fig. 14.

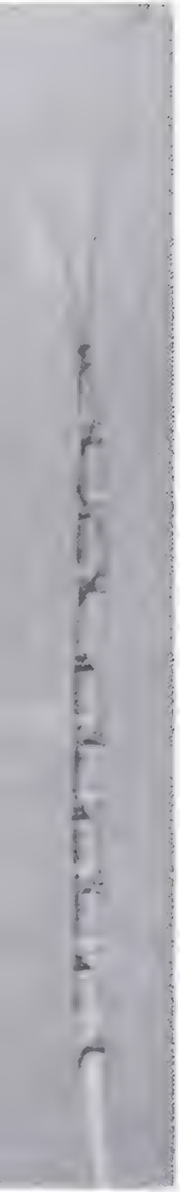
Table 18. Morphological characters and seed-fertility of the strains of *Ae. squarrosa* from eight regions in the inter-regional crosses and of three strains (Nos. 1, 2 and 3) from the old collection of Kyoto Univ

Stock No.	Region (Locality)	Variety	Ear					Height (cm)	
			Length	Thickness	Awn	Color	Form		
2001	Quetta (Quetta)	*typica*	long	thick	long	black	cylindrical	~65	er
2047	Kabul (Kabul)	〃	〃	〃	〃	〃	〃	~80	
2058	Pul-i-Khumri (Haibak)	intermediate type*	short	thin	short	yellow	〃	~65	
2095	Maimana (Maimana – Laman)	*anathera*	long	〃	awnless	〃	〃	~65	
2129	Tehran (Khoshyailagh)	*typica*	〃	thick	long	brown	zigzag	~65	se
2135	Gorgan (Sari – Behshahr)	*strangulata*	short	〃	〃	black	cylindrical	~80	er
2144	Pahlavi (Ramsar)	*meyeri*	〃	thin	〃	〃	〃	~50	p
2173	Tabriz (Khoy – Tabriz)	intermediate type*	long	thick	short	brown	〃	~80	se
1	Derbent, USSR	*typica*	〃	〃	long	black	zigzag	~65	er
2	——	〃	〃	〃	〃	〃	cylindrical	~65	
3	Tashkent, USSR	〃	〃	〃	〃	brown	〃	~65	

* Intermediate type between var. *typica* and var. *anathera*.

Fig. 13. Ears of intra-species hybrids of *Ae. squarrosa*

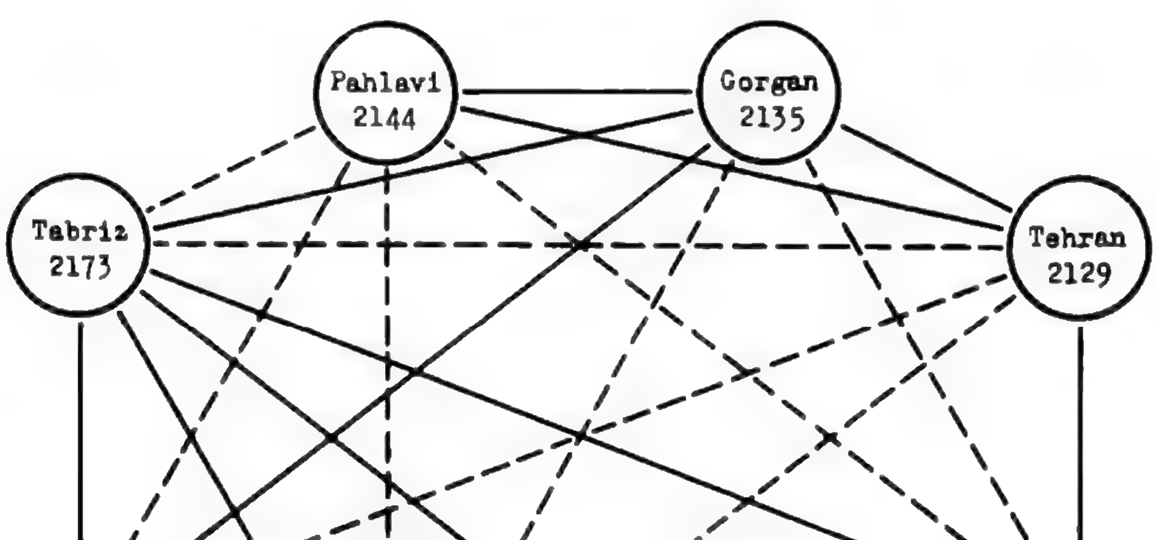
a. var. *meyeri* × var. *typica*, b. var. *meyeri* × var. *anathera*,
c. 〃 × intermediate, d. 〃 × ssp. *strangulata*,
e. ssp. *strangulata* × var. *typica*, f. ssp. *strangulata* × intermediate,
g. 〃 × var. *anathera*



species hybrids
ar. *typica*
hera
anathera,
ntermediate,
r. *typica*

Table 19. Pollen- and seed-fertility in the hybrids of the inter-regional combinations in *Ae. squarrosa* (Seed-fertility is given in parenthesis.)

Parents	Quetta No. 2001	Kabul No. 2047	Pul-i-Khumri No. 2058	Maimana No. 2095	Tehran No. 2129	Gorgan No. 2135	Pahlavi No. 2144	Tabriz No. 2173
Quetta No. 2001	(88.0)							
Kabul No. 2047	84.6 (82.6)	(93.1)						
Pul-i- Khumri No. 2058	87.1 (88.3)	94.5 (85.7)	(92.7)					
Maimana No. 2095	88.2 (90.3)	—	95.4 (96.3)	(92.7)				
Tehran No. 2129	83.6 (77.2)	90.6 (70.8)	—	97.3 (87.1)	(84.3)			
Gorgan No. 2135	89.4 (89.0)	90.2 (71.2)	—	89.4 (46.3)	95.0 (90.9)	(92.0)		
Pahlavi No. 2144	72.3 (50.5)	80.2 (72.8)	—	88.4 (75.0)	90.4 (84.2)	94.6 (95.5)	(81.9)	
Tabriz No. 2173	91.5 (88.0)	92.8 (90.8)	96.5 (97.7)	93.6 (85.7)	89.3 (73.5)	84.1 (80.2)	87.4 (74.1)	(93.1)



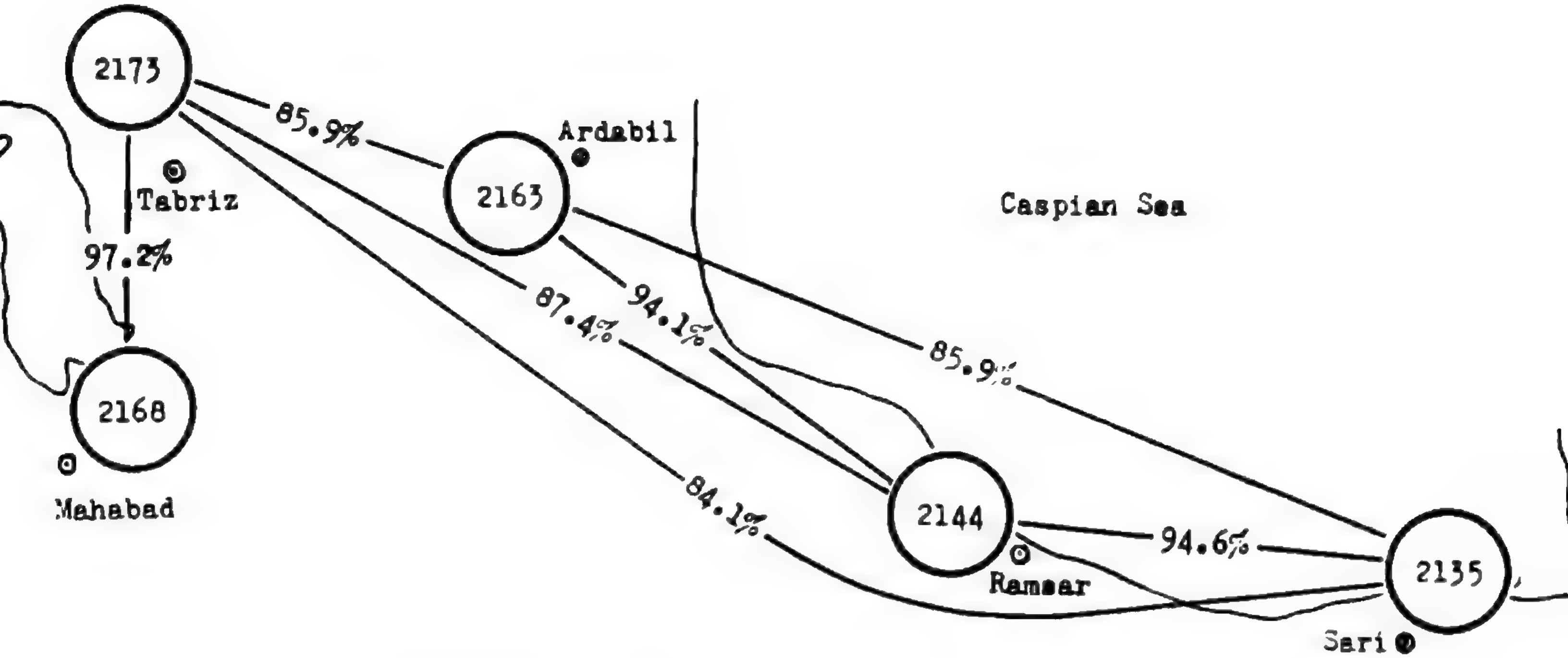


Fig. 15. Relationships of seed-fertility in inter-strain hybrids of three neighboring regions (Numeral on the line indicates seed-fertility.)

low fertility may depend on minor differences in the genotypes of the parents and also on enviromental conditions.

With respect to hybrid sterilities, three old strains, Nos. 1, 2 and 3, maintained for many years in Kyoto were used for further studies. The fertility relationships among them can be seen from Fig. 16. There was no significant difference in the reciprocal crosses after KIHARA (1954). This results can be explained by the presence of two duplicate genes for the fertility of gametes. Namely No. 1 possesses two dominant genes (A_1 and A_2), while No. 2 and No. 3 have A_1 or A_2. Accordingly sterile gametes having two recessive alleles (a_1a_2) will be produced by recombination in the hybrids between No. 2 and No. 3.

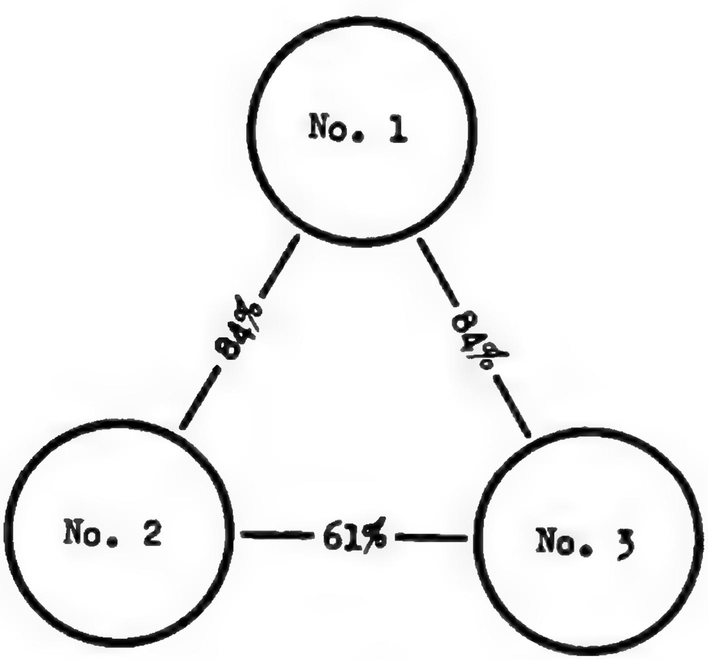
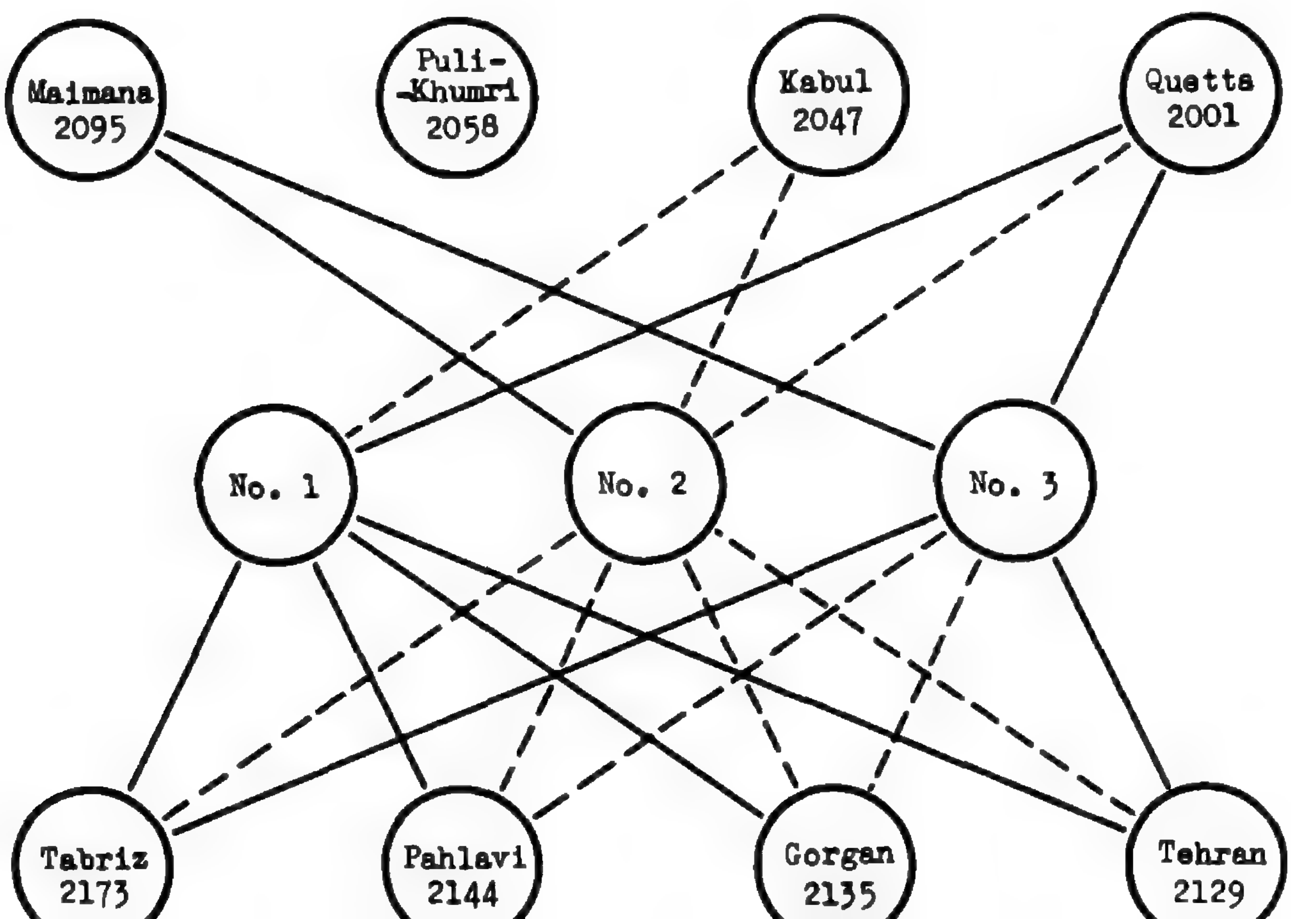


Table 20. Pollen- and seed-fertilities in F_1 hybrids of *Ae. squarrosa* between Nos. 1, 2 and 3 and eight strains representing eight regions

Parents		No. 1		No. 2		No. 3	
		Pollen	Seed	Pollen	Seed	Pollen	Seed
Quetta	(No. 2001)	88.6%	87.5%	85.6%	74.4%	94.5%	89.0%
Kabul	(No. 2047)	87.3	60.3	90.5	79.5	—	—
Pul-i-Khumri	(No. 2058)	—	—	—	—	—	—
Maimana	(No. 2095)	—	—	91.0	89.7	—	87.4
Tehran	(No. 2129)	94.6	89.1	80.3	71.2	88.9	95.8
Gorgan	(No. 2135)	92.1	95.8	82.4	70.0	84.9	52.9
Pahlavi	(No. 2144)	96.8	88.1	89.7	76.1	—	63.2
Tabriz	(No. 2173)	84.7	91.1	73.1	77.7	94.2	97.6

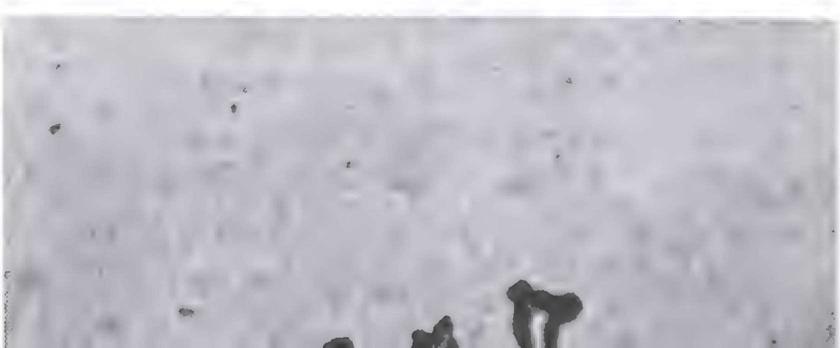


gulata, var. *typica* and intermediate types grew mixed together.

By further crossing experiments, a ring of four chromosomes was found in addition to five pairs in all hybrids of No. 2107 with 10 other strains, as given in Table 21 and Fig. 18. Therefore it can be assumed that No. 2107 had a reciprocal translocation. The frequency of PMC's with a ring of four chromosomes amounted to 97.2%~99.0% (an average being 97.8%). The frequency of alterna-

Table 21. Chromosome pairing and fertility in the hybrids of No. 2107 and other strains of *Ae. squarrosa*

Cross combination	No. of PMC's observed	④+5$_{\text{II}}$	7$_{\text{II}}$	Frequency of ④+5$_{\text{II}}$ (%)	Frequency of the types of ④		Pollen-fertility (%)	Seed-fertility (%)
					∞	○		
2107×2095	330	321	9	97.3	171 (53.3%)	150 (46.7%)	81.4	31.0
×2106	135	132	3	98.5	76 (57.6)	56 (42.4)	81.2	74.0
×2108	565	553	12	97.7	331 (59.9)	222 (40.1)	87.4	54.0
×2129	108	105	3	97.2	69 (64.8)	36 (35.2)	84.7	—
×2130	177	172	5	97.2	100 (58.2)	72 (41.8)	90.5	70.0
×2172	441	432	9	97.9	258 (59.7)	174 (40.3)	87.7	76.2
×2176	104	103	1	99.0	67 (65.1)	36 (34.9)	89.3	69.0
×2180	243	236	7	97.1	152 (64.4)	84 (35.6)	90.9	69.5
×2181	246	242	4	98.3	151 (62.4)	91 (37.6)	89.6	73.0
×2182	715	701	14	98.0	448 (64.0)	253 (36.0)	89.6	70.5



tive or zigzag configurations of the ring of four chromosomes ranged from 53.3 to 65.1% (an average being 59.4%).

The pollen-fertility or the percentage of stainable good pollen grains in those hybrids was 81.2~90.9% (an average being 87.2%). The seed-fertility was 31.0~76.2% (an average being 65.2%).

No. 2107 was found in a collection from a habitat 1~2 km from Karaj, Iran. It was one of three strains separated morphologically from the collection, namely, No. 2107 with thick ears, No. 2108 with intermediate ears and No. 2109 with thin ears. Nos. 2108 and 2109 have no reciprocal translocation.

(ii) Morphological observations of hybrids

Height of culms of F_1 hybrids is given in Table 22. The hybrid plants were higher than the parents in many cross combinations. In some cases, however, the hybrid plants were intermediate between the parents, while in a few cases they were shorter than the parents. The data of other morphological analyses of F_1 hybrids are given in Table 23. It is not clear from these observations whether the respective characteristics can be explained on the basis of one or more genes.

Table 22. Culm height in F_1 hybrids

Number of cross combinations of *Ae. squarrosa* which gave hybrids:		
taller than the parents	intermediate between the parents	shorter than the parents
20	11	5

Table 23. The phenotypes of F_1 hybrids of *Ae. squarrosa* in regard to various morphological characters

Character	Cross combination	F_1 hybrid
Procumbent habit	standing × procumbent	procumbent

(iii) Physiological observations

The flowering dates in the F_1 hybrids were also observed, as given in Table 24. In the cross combinations of var. *typica* × var. *typica* and var. *typica* × var. *meyeri*, almost all hybrids showed intermediate flowering dates between the parents, while in the cross combinations of var. *typica* × ssp. *strangulata* they showed earlier flowering dates than the parents.

Table 24. Flowering date in F_1 hybrids

Cross combination	Earlier than the parents	Intermediate between the parents	Later than the parents
typica × *typica*	5	19	4
typica × *meyeri*	1	5	1
typica × *strangulata*	5	2	2
meyeri × *strangulata*	1	—	—

e. Some aspects regarding the centre of diversity

Variations of various characters are listed in Table 25.

Throughout the whole route of the expedition which extended from Quetta to Tabriz (Isfahan excepted), *Ae. squarrosa* was found almost continuously, but not a single specimen was collected between Mashhad and Tehran. However, KUCKUCK (1954), who stayed for three years in Tehran as an FAO expert, collected *Ae. squarrosa* in the province of Khorasan, near Mashhad, Chuchan, Bojnurd and Sabzawar. There he obtained also three other species, *Ae. triuncialis, cylindrica* and *crassa*.

In the mountainous districts (Damaneh and Shahr-Kord) of Isfahan, no *Aegilops* species was found. Neither could KUCKUCK during his two collecting tours succeed in finding *Aegilops*. The conditions in the spelt region (altitude 2,000～2,380 meters) probably are, as he states, unfavorable to *Aegilops*.

In Azerbaijan, KUCKUCK failed to collect *Ae. squarrosa*, though he found many other *Aegilops* species. However we were fortunate in finding *Ae. squarrosa* in many places along the route around Lake Rezaiyeh, as shown in Figs. 1, 9 and 12.

Table 25. Variations in morphological characteristics in the strains of *Ae. squarrosa* collected in Pakistan, Afghanistan and Iran

Character / Region	Ear		Awn of lateral spikelet			Ear color		
	short	long	long	intermediate	awnless	black	purple	yellow
Pakistan and Afghanistan	+	−	+	+	+	+	+	+
Iran	+	+	+	+	+	+	−	+

Region	Ear type		Grain size		Grain shape		Color of seedling		Height (cm)			
	cylindrical	zigzag	large	small	long	round	red	green	~50	50~65	65~80	80~
Pakistan and Afghanistan	+	−	−	+	+	−	+	+	+	+	+	−
Iran	+	+	+	+	+	+	+	+	+	+	+	+

Region	Procumbent or erect				Leaf		Shooting		
	procumbent	semi-procumbent	semi-erect	erect	non-waxy	waxy	early	intermediate	late
Pakistan and Afghanistan	−	+	+	−	+	−	+	+	−
Iran	+	+	+	+	+	+	−	+	+

Region	Growing habit			Reaction to rust				Total of + characters
				P. triticina		*P. graminis* f. sp. *tritici*		
	winter	intermediate	spring	susc.	resist.	susc.	resist.	
Pakistan and Afghanistan	+	+	+	+	−	+	−	25
Iran	+	−	−	+	+	+	+	32

F. N.: + or − indicates the presence or absence of corresponding characters.

tion is harvested together with the wheat and sown together in a different place. If this process were repeated for many generations, this *squarrosa*-strain would

meyeri is distributed along the south-western shore (Pahlavi), while ssp. *strangulata* is found along the south-eastern shore near Gorgan. Both of them showed resistance to certain rust strains. This character might be advantageous for them as these regions are humid and plants are easily diseased by fungi. In general we might say that physiological mutants grow in their respective habitats owing to their adaptation. Among morphological characteristics, plant height seems to be also subjected to natural selection. In Gorgan weeds are luxuriant and tall, and ssp. *strangulata*, the only representative of this species in this area, is very tall.

A wealth of various forms of *Ae. squarrosa* was encountered in Iran, especially the districts around the Elburz Mountains. Here almost all of the variations were concentrated. Among them occurred types which distinguish cultivated plants from their wild ancestral forms, namely rust resistance, erect habit, green seedlings, zigzag ear, large round grains and height. Waxy leaves may be also counted as such characters. Their occurrence indicates the existence of long duration under semi-cultivated conditions.

2. *Aegilops crassa* Boiss.
(2n=28 and 42, genome symbols $DDM^{cr}M^{cr}$ and $DDD_2D_2M^{cr}M^{cr}$)

a. Collected materials and their geographical distribution

Ae. crassa includes two polyploid forms, 4x and 6x. *Ae. crassa* has been known to be distributed through Palestine, Syria, Iraq, Iran, Afghanistan and Turkestan (Eig 1929), but the respective geographical distributions of the 4x and 6x forms have not been established as yet. In our old stock, however, one strain from Iraq was 4x, while one from Tashkent in Turkestan, U. S. S. R. was 6x.

A considerable number of *Ae. crassa* strains were collected in Afghanistan and Iran (Tables 26, 27). Our studies revealed that all the strains from Iran were 4x, while in Pul-i-Khumri and Maimana, Afghanistan, 4x and 6x grew

Table 26. List of *Ae. crassa* Boiss. collected in Afghanistan and Iran

Stock No.	Ploidy	Variety	Locality or source	Growth habit	Collector[1)]
2301-6	4x	New variety (awnless type)	Kandahar – Jaldak, Afghanistan	W-S	K, Y

Table 26. (Continued)

2311–5	4x		Pul-i-Khumri – Haibak,	Afghanistan	S	Y
2311–6	6x		〃	〃	W–S	〃
2312–1	〃		〃	〃	W–S	〃
2315–5	4x		〃	〃	W–S	〃
2317–4	6x		〃	〃	S	〃
2318–1	〃		〃	〃	S	〃
2320–1	〃		〃	〃	S	〃
2322–1	〃		Maimana – Laman,	〃	W–S	〃
2322–4	4x		〃	〃		〃
2325–2	6x		〃	〃	S	〃
2327–1	4x		〃	〃	S	〃
2328–1	6x		〃	〃	S	〃
2329–1	〃		Laman,	〃		〃
2330–2	〃		Laman – Herat,	〃	S	〃
2331–8	4x		〃	〃		〃
2332–1	6x		〃	〃	S	Y
2334–3	4x		Ghazvin,	Iran	S	K
2336–3	〃		〃	〃		〃
2337–2	〃		〃	〃	S	〃
2338–5	〃		Tabriz – Mahabad,	〃	W–S	〃
2340–5	〃		Mahabad – Rezaiyeh,	〃		〃
2341–2	〃		〃	〃		〃
2342–1	〃		〃	〃	W–S	〃
2343–3	〃		〃	〃		〃
2345–2	〃		〃	〃	W–S	〃
			Mixed in chicken feed,			

Table 26. (Continued)

2356-1	4x		Collection of Agr. Exp. Sta. Tehran,	Iran
2357-6	〃		〃	〃
2358-2	6x		〃	〃

1) K: H. KIHARA, Y: K. YAMASHITA.

Table 27. *Ae. crassa* collected in Afghanistan and Iran

Region	Habitats	Strains	4x	6x
Afghanistan:				
Kandahar*	2	9	9	0
Pul-i-Khumri	7	13	2	11
Maimana	7	12	3	9
Iran:				
Tehran	2	5	5	0
Tabriz	10	10	10	0

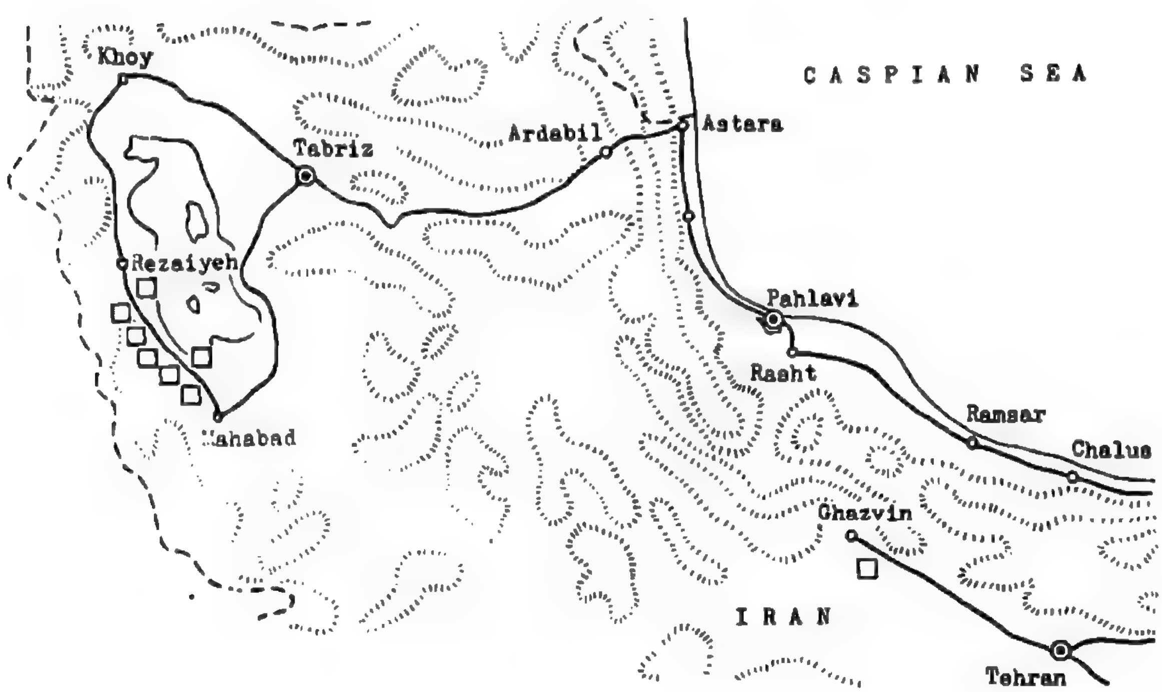
* Kandahar is included in the Kabul region.

mixed, and in Kandahar and Jaldak, in the southern province of Afghanistan, 6x was not found (Figs. 19, 20).

As given in Table 28, many strains of this species were collected in seven habitats along the highway from Pul-i-Khumri to Haibak, and also in seven habitats from Maimana to Herat in Afghanistan. It was found that 6x plants predominated in the Pul-i-Khumri and Maimana regions. Namely, two habitats in Pul-i-Khumri - Haibak and two habitats in Maimana - Herat contained associations of 6x and 4x forms (Fig. 21). Besides, one population in Maimana - Herat was found to be pure 4x, while other populations, five in Pul-i-Khumri - Haibak and four in Maimana - Herat, were pure 6x.

The progenies of the samples of *Ae. crassa* collected in Afghanistan were

Fig. 19. Habitats of *Ae. crassa* (□ 4x, ■ 6x) in Afghanistan



a b c d

Fig. 21. 4x and 6x *Ae. crassa* collected in the Maimana region, Afghanistan

a. No. 2322–4 (4x), b. No. 2322–1 (6x),
c. No. 2331–8 (4x), d. No. 2330–2 (6x)

Table 29. Cytological results in the progeny from the seeds of *Ae. crassa* growing mixed with other species

Habitat	Plants observed	4x	6x	Hybrids	Mixture

Hindukush range, where it was found mixed with 4x form.

b. Morphological characters

The culm height of the 4x strains from Afghanistan and Iran was 40~55 cm and that of the 6x strains from Afghanistan was 50~70 cm (Table 30).

Table 30. Variation in plant height in *Ae. crassa* obtained from five regions

Region		Number of strains with the height (cm)			
		~45	45~55	55~65	65~
Kabul	4x	5	1	0	0
Pul-i-Khumri	4x	1	2	0	0
	6x	0	3	2	0
Maimana	4x	1	2	0	0
	6x	0	1	3	2
Tehran	4x	2	1	0	0
Tabriz	4x	3	7	0	0
Total		12	17	5	2

There are distinct differences between Afghan and Iranian strains of *Ae. crassa*. Namely, the Iranian group is procumbent and has narrow, dark-green leaves, while the Afghan group is erect and has broad, light-green leaves.

In Kandahar and Jaldak in Afghanistan, a new awnless 4x type was found. Namely the strains of *Ae. crassa* from the habitats in Kandahar and Jaldak were all 4x and were awnless or very short awned type (Fig. 22), which has not yet been described in any of the two monographs of the genus *Aegilops* by ZHUKOVSKY (1928) and EIG (1929). This form can be a new variety.

The awnless type is inherited in a more or less simple Mendelian fashion, awnless being dominant over awned. The segregation in F_2 was 48 : 17 being about 3 : 1.

After EIG (1929), *Ae. crassa* is divided into four varieties, namely var. *typica* BOISS., var. *glumiaristata* EIG, var. *macrathera* BOISS. and var. *palaestina* EIG.

a b

Fig. 22. The new type of 4x *crassa* collected in Kandahar – Jaldak, Afghanistan (No. 2306–7)

is most probably $DM^{cr}S^{l}$; hence, it would have to be recognized as a new species. It may be the same which CHENNAVEERAIAH (1960) established as a new species *Ae. vavilovii*, from his karyotype studies.

c. Physiological characters

(i) Flowering date

45 out of 58 strains of *Ae. crassa* have been observed for flowering date in the experiment field in Kyoto. As shown in Table 31, there are significant differences in the flowering date between Afghan and Iranian strains. Iranian

Table 31. Frequency of strains with various flowering dates in *Ae. crassa*

Region	Flowering date observed in Kyoto, 1956								
	~11/V		~16/V		~21/V		~26/V		Total
	4x	6x	4x	6x	4x	6x	4x	6x	
Afghanistan:									
Kabul	0	—	9	—	0	—	0	—	9
Pul-i-Khumri	0	2	3	6	0	0	0	0	11
Maimana	1	0	1	4	1	4	0	0	11
Total	1	2	13	10	1	4	0	0	31
Iran:									
Tehran	0	—	0	—	4	—	0	—	4
Tabriz	0	—	0	—	5	—	5	—	10
Total	0	—	0	—	9	—	5	—	14

Table 32. Results of the experiments on the shooting and growth habits in *Ae. crassa*

Region	Habitat	Stock No.	Chromosome number (n)	Shooting habit[1] March[2] 20	Shooting habit[1] April[2] 20	Growth habit[3]
Afghanistan:						
Kabul	Kandahar	2301	14	+	−	I
	Jaldak	2302	14	+	−	I
	〃	2306	14	+	−	I
	〃	2309	14	+	+	S
Pul-i-Khumri	Pul-i-Khumri – Haibak	2310	21	+	−	I
	〃	2311-5	14	+	+	S
	〃	2311-6	21	+	−	I
	〃	2312	21	+	−	I
	〃	2315	14	+	−	I

Table 32. (Continued)

Iran : Tehran	Laman	2330	21	+	+	S
	Laman – Herat	2332	21	+	+	S
	Ghazvin	2334	14	+	+	S
	〃	2337	14	+	+	S
	Tabriz – Mahabad	2338	14	+	–	I
	〃	2342	14	+	–	I
	Mahabad – Rezaiyeh	2345	14	+	–	I

1) + : headed, – : not headed.
2) Dates of sowing time.
3) I : intermediate-type, S : spring-type.

Table 33. Distribution of winter-, intermediate- and spring-types in *Ae. crassa*

Region	Winter		Intermediate		Spring		Total
	4x	6x	4x	6x	4x	6x	
Afghanistan :							
Kabul	0	0	3	0	1	0	4
Pul-i-Khumri	0	0	1	3	1	3	8
Maimana	0	0	0	1	1	4	6
Total	0	0	4	4	3	7	18
Iran :							
Tehran	0	—	0	—	2	—	2
Tabriz	0	—	3	—	0	—	3
Total	0	—	3	—	2	—	5

the winter growing habit. They are thought to be the ancestral types. It is interesting that the spring-type predominated and occurred in a majority in spite

Table 34. Comparison of seed-fertility between materials from the original habitat and those from the experiment field in Kyoto, in *Ae. crassa*

Material		Seed-fertility				
		~20%	~40%	~60%	~80%	~100%
4x	Original habitat (1955)	0	0	4	10	14
	Experiment field (1956)	0	0	2	13	9
6x	Original habitat (1955)	1	2	8	4	2
	Experiment field (1956)	0	0	1	3	15

its original habitats.

d. Origin of 6x *crassa*

Apical upper margin of empty glume is one of the characteristics represented by M-genome, while, truncate upper margin of empty glume is the one represented by D-genome of *Ae. squarrosa*. 4x exhibits the former character while 6x the latter one. Futhermore 4x has a nodose ear, while 6x has more or less a cylindrical ear which might be attributed to the double dose of D-genomes. From these facts, it can be said that the third genome involved in the 6x form is supposed to be D-genome, which is found in *Ae. squarrosa*. The hybrid between 4x and 6x forms showed the chromosome pairing of as many as 14_{II}. However there were more multivalents, indicating the duplication of D-genomes.

An amphidiploid was obtained by colchicine method from the cross between *Ae. crassa* 4x ($DDM^{cr}M^{cr}$) and *Ae. squarrosa* (DD). The genome constitution of the amphidiploid should be $DDM^{cr}M^{cr}DD$. The synthesized amphidiploid is quite similar to the 6x species of *Ae. crassa* morphologicaly (Figs. 23, 24). The chromosome pairing, pollen- and seed-fertility of the amphidiploid are given in Table 35. The chromosome pairing of the plant is good (average number of bivalents


a b c d e

Fig. 24. Ears of *Ae. crassa* 4x (a), *Ae. squarrosa* (b), synthesized amphidiploid, $DDM^{cr}M^{cr}DD$ (*crassa* 4x × *squarrosa*) (c), *Ae. crassa* 6x (d), and ($DDM^{cr}M^{cr}DD$ × *crassa* 6x) F_1 (e)

Table 35. Chromosome pairing (per cell) and fertility of the

per cell is 20.57) and its fertility is nearly normal.

The hybrid between the amphidiploid and *Ae. crassa* 6x was raised for further investigations (Table 36). The hybrid showed rather good chromosome pairing on the average, namely maximum pairing was about 19_{II}, and the fertility was high, namely the pollen-fertility was 68.9% and the seed-fertility was 89.1%.

Table 36. Chromosome pairing (per cell) and fertility of the hybrid between the synthesized amphidiploid $DDM^{cr}M^{cr}DD$ and *Ae. crassa* 6x

Combination	Univalents	Bivalents	Trivalents	Tetravalents	Higher multivalents	Average pairing	Fertility (%)	
							Pollen	Seed
Ae. crassa 6x × $DDM^{cr}M^{cr}DD$	2.0	14.02	1.56	1.34	0.24	18.92	68.8	89.1

Based on these data it will be concluded that *Ae. crassa* 6x might have arisen as an amphidiploid of the hybrid between *Ae. crassa* 4x with DM^{cr}-genomes and *Ae. squarrosa* with D-genome.

The 4x form of *Ae. crassa* could have originated somewhere in or around Asia Minor. From the fact that both 4x and 6x forms were found in a mixture in the northern stretch of the Hindukush Range in Afghanistan, namely in the Maimana and Pul-i-Khumri regions, it can be said that the 6x form originated there from the cross between the 4x form of *Ae. crassa* ($DDM^{cr}M^{cr}$) and *Ae. squarrosa* (DD).

3. *Ae. triuncialis* L. (2n=28, genome symbol CCC^uC^u)

a. Collected materials and geographical distribution

After EIG (1929), *Ae. triuncialis* L., a tetraploid species, is divided into two subspecies, namely *eu-triuncialis* EIG and *orientalis* EIG. Ssp. *eu-triuncialis* has two varieties, *typica* L. and *constantinopolitana* EIG, while ssp. *orientalis* has three varieties, *assyriaca* EIG, *persica* (BOISS.) EIG and *anathera* HAUS. *et* BORNM.

After EIG (1929), the geographical distribution of *Ae. triuncialis* is very

Table 37. List of *Ae. triuncialis* L. collected in Afghanistan and Iran

Stock No.	Variety	Locality or source	Waxiness of ear	Collector[1]
2502–2	var. *typica* L.	Pul-i-Khumri – Haibak, Afghanistan	non-waxy	Y
2502–8	〃	〃 〃	waxy	〃
2503–1	〃	〃 〃	non-waxy	〃
2505–1	〃	〃 〃	waxy	〃
2505–4	〃	〃 〃	non-waxy	〃
2506–1	〃	〃 〃	〃	〃
2507–1	〃	〃 〃	waxy	〃
2508–5	〃	〃 〃	non-waxy	〃
2509–8	〃	〃 〃	waxy	〃
2509–5	〃	〃 〃	non-waxy	〃
2510–5	〃	〃 〃	〃	〃
2511–7	〃	〃 〃	waxy	〃
2511–2	〃	〃 〃	non-waxy	〃
2513–1	var. *assyriaca* Eig	Maimana – Laman, 〃	waxy	〃
2517–1	〃	〃 〃	non-waxy	〃
2519–3	var. *persica* (Boiss.) Eig	〃 〃	waxy	〃
2522–3	var. *assyriaca* Eig	〃 〃	non-waxy	〃
2522–10	〃	〃 〃	waxy	〃
2523–6	var. *persica* (Boiss.) Eig	〃 〃	〃	〃
2524–9	〃	〃 〃	non-waxy	〃
2525–9	〃	〃 〃	waxy	〃
2526–4	var. *assyriaca* Eig	〃 〃	non-waxy	〃
2527–3	〃	〃 〃	waxy	〃
2528–3	〃	〃 〃	non-waxy	〃

Table 37. (Continued)

2533-6	var. *persica* (BOISS.) EIG	Laman,	Afghanistan	waxy	Y
2534-4	var. *assyriaca* EIG	Laman - Herat,	〃	non-waxy	〃
2537-6	var. *typica* L.	Nishabur - Sabzawar,	Iran	waxy	〃
2404-3	〃	Ghazvin,	〃	〃	K
2541-5	〃	〃	〃	non-waxy	〃
2549-1	〃	〃	〃	non-waxy	〃
2549-9	〃	〃	〃	waxy	〃
2550-5	〃	〃	〃	non-waxy	〃
2554-1	〃	〃	〃	〃	〃
2556-3	〃	〃	〃	〃	〃
2561-4	〃	〃	〃	〃	〃
2407-1	〃	〃	〃	waxy	〃
2408-1	〃	〃	〃	〃	〃
2562-4	〃	〃	〃	non-waxy	〃
2565-9	〃	〃	〃	〃	〃
2569-9	〃	〃	〃	〃	〃
2572-3	〃	Karaj,	〃	〃	〃
2572-6	〃	〃	〃	waxy	〃
2575-6	〃	〃	〃	〃	〃
2576-11	〃	〃	〃	non-waxy	〃
2577-1	〃	Gorgan - Khoshyailagh,	〃	〃	〃
2578-10	〃	〃	〃	〃	〃
2579-2	〃	Tehran,	〃	〃	〃
2580-2	〃	〃	〃	〃	〃
2582-9	〃	〃	〃	〃	〃

Table 37. (Continued)

2593-5	var. *typica* L.	Tabriz – Mahabad,	Iran	non-waxy	K
2595-10	〃	Mahabad,	〃	〃	〃
2596-1	〃	Mahabad – Rezaiyeh,	〃	〃	〃
2604-2	〃	〃	〃	〃	〃
2604-10	〃	〃	〃	waxy	〃
2605-1	〃	〃	〃	non-waxy	〃
2607-1	〃	〃	〃	〃	〃
2608-3	〃	Rezaiyeh – Khoy,	〃	〃	〃
2610-2	〃	〃	〃	〃	〃
2613-5	〃	〃	〃	〃	〃
2614-1	〃	Khoy,	〃	〃	〃
2615-1	〃	Khoy – Tabriz,	〃	〃	〃
2616-7	〃	〃	〃	〃	〃
2617-1	〃	Mixed in chicken feed in Tabriz,	〃	〃	Y
2618-2	〃	〃	〃	〃	〃
2451-2	var. *assyriaca* Eig	〃	〃	〃	〃
2621-7	var. *typica* L.	Collection of Agr. Exp. Sta., Tehran,	〃	〃	
2624-3	new variety ?	〃	〃	〃	
2625-1	var. *typica* L.	〃	〃	〃	
2627-4	〃	〃	〃	〃	
2628-2	〃	〃	〃	〃	
2629-3	〃	〃	〃	〃	
2630-1	〃	〃	〃	〃	
2631-1	〃	〃	〃	〃	
2632-4	〃	〃	〃	waxy	
2633-1	〃	〃	〃	non-waxy	

Table 37. (Continued)

2641-11	var. *persica* (BOISS.) EIG	Collection of Agr. Exp. Sta., Tehran.	Iran	non-waxy
2642-1	var. *typica* L.	〃	〃	〃
2643-2	〃	〃	〃	〃
2644-1	〃	〃	〃	〃
2645-2	〃	〃	〃	〃
2646-3	〃	〃	〃	〃
2648-2	〃	〃	〃	〃
2649-4	〃	〃	〃	〃
2650-1	〃	〃	〃	waxy
2652-4	var. *persica* (BOISS.) EIG	〃	〃	non-waxy

1) K: H. KIHARA, Y: K. YAMASHITA.

Table 38. Distribution of the varieties of *Ae. triuncialis* in Iran and Afghanistan

Region	Variety	Habitats	Strains
Afghanistan:			
Pul-i-Khumri	*typica*	10	14
Maimana	*persica*	3	4
	persica+*assyriaca* mixed	2	2
	assyriaca	6	10
Total		21	30
Iran:			
Tehran	*typica*	9	24
Gorgan	*typica*	2	2
Tabriz	*typica*	15	18
Total		26	44

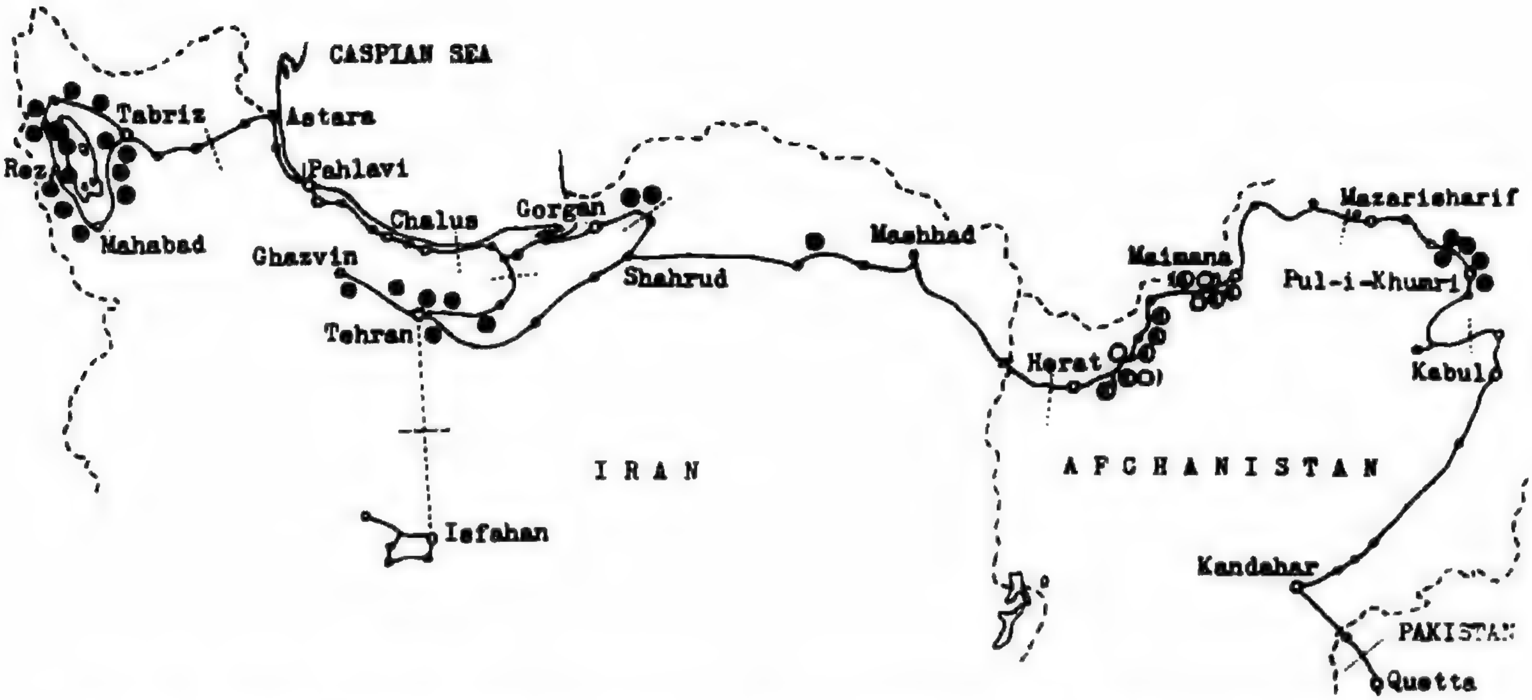


Fig. 25. Map showing the localities of *Ae. triuncialis* along the route of KUSE
● *typica*, ◐ *assyriaca*, ○ *persica*, ( ) mixed population

b. Morphological characters

Ssp. *eu-triuncialis* EIG (Fig. 26)

Both sterile and outer glumes of apical spikelet have 2～3 awns and also sterile glumes of all lateral spikelets are awned. Disarticulation of the ear is umbrella

Fig. 26. Ears of *Ae. triuncialis*
a～e : ssp. *eu-triuncialis* var. *typica* collected in the Pul-i-Khumri region,
f～j : ssp. *orientalis* var. *assyriaca* collected in the Maimana region,
k～n : ssp. *orientalis* var. *persica* collected in the Maimana region,
o～s : ssp. *eu-triuncialis* var. *typica*

f. No. 2513–1,
g. No. 2529–1,
h. No. 2530–2,
i. No. 2532–5,
j. No. 2528–3

f g h i j

Fig. 26. (Continued) f ~ j

k. No. 2524–3

o p q r s

o. No. 2541- 5,
p. No. 2408- 2,
q. No. 2578-10,
r. No. 2580- 2,
s. No. 2584- 2

Fig. 26. (Continued) o ~ s

t. No. 2595-10,
u. No. 2604-10,
v. No. 2607- 1,

type with no exception.

Ssp. *orientalis* EIG (Fig. 26)

In apical spikelet, sterile glume has 1~3 awns or none, while outer glume has none. Disarticulation of the ear is umbrella type or sometimes barrel type.

Var. *assyriaca* EIG has one slender awn in lateral spikelet, while var. *persica* (BOISS.) EIG has 1~2 short awns or teeth in upper spikelet. It was observed that vars. *assyriaca* and *persica* occur side by side in common populations in the Maimana region. Therefore, there is a possibility of hybridization between the two varieties. Probably for this reason, wide and continuous variation was found between the two varieties. Accordingly, it was difficult to give a clearcut classification between vars. *assyriaca* and *persica* based on the morphological differences.

According to MATSUMURA and KONDO (1942) the awned character is incompletely dominant over the non-awned in *Ae. triuncialis*.

(i) Height of culm

The plants were classified under four classes by their height, namely less than 35, 35~45, 45~55 and 55~65 cm, as given in Table 39. Taller plants were found in the Tabriz and Maimana regions.

Table 39. Variation in plant height in *Ae. triuncialis*

Region	Number of strains with the height			
	~35 cm	~45 cm	~55 cm	~65 cm
Afghanistan :				
Pul-i-Khumri	1	11	1	0
Maimana	0	9	10	0
Total	1	20	11	0
Iran :				
Tehran	2	18	4	0
Gorgan	0	0	2	0
Tabriz	0	2	11	4

homozygous or heterozyous. Actually all waxy plants gave rise to waxy progenies, while some of the non-waxy plants segregated waxy progenies, indicating that hybridization occurred between waxy and non-waxy in nature.

Table 40. Frequency of waxy and non-waxy populations in *Ae. triuncialis*

Region	Habitats	Non-waxy populations	Waxy populations	Mixed populations (non-waxy : waxy)
Afghanistan:				
Pul-i-Khumri	10	5	1	4 (22 : 10)
Maimana	11	4	2	5 (37 : 42)
Iran:				
Tehran	9	5	1	3 (98 : 14)
Gorgan	2	2	0	0
Tabriz	15	14	0	1 (9 : 5)
Total	47	30	4	13 (166 : 71)

(iii) Glume pubescence

In almost all *Aegilops* species, both pubescent and glabrous types are found, pubescent being dominant over glabrous. The distribution of these characters is given in Table 41.

Among 47 habitats, the strains from 25 habitats were pubescent and the strains from 14 habitats were glabrous, while both pubescent and glabrous strains were collected from the remaining eight habitats.

The glabrous type is probably a mutation from the pubescent type. It is noteworthy that the glabrous plants occurred in an overwhelming majority in the Pul-i-Khumri region.

Table 41. Frequency of pubescent or glabrous in *Ae. triuncialis*

Region	Number of habitats:		
	pubescent	glabrous	mixed

c. Physiological characters

(i) Shooting date

Early, intermediate and late shooting types were found in the strains of *Ae. triuncialis*, as given in Table 42.

There was a marked tendency to late shooting in the strains from Iran, while early shooting types were found more often in the strains from Afghanistan.

Table 42. Frequency of early and late shooting strains of *Ae. triuncialis* obtained from five regions and other source

Region or source	Shooting date observed in Kyoto, 1956					
	~5/V	~10/V	~15/V	~20/V	~25/V	~31/V
Afghanistan:						
Pul-i-Khumri	2	5	2	2	2	0
Maimana	0	7	7	4	2	0
Iran:						
Tehran	0	0	3	6	7	0
Gorgan	0	0	0	0	2	0
Tabriz	0	0	0	4	7	4
Agr. Exp. Sta., Tehran	2	0	2	4	13	2
Total	4	12	14	20	33	6

(ii) Seed-fertility

As shown in Table 43, the fertility of the samples from the original habitats in 1955 was much higher than that of those from the cultivation in the experiment field in Kyoto in 1956. The low fertility of the latter is probably due to the influence of the rainy conditions during the flowering time.

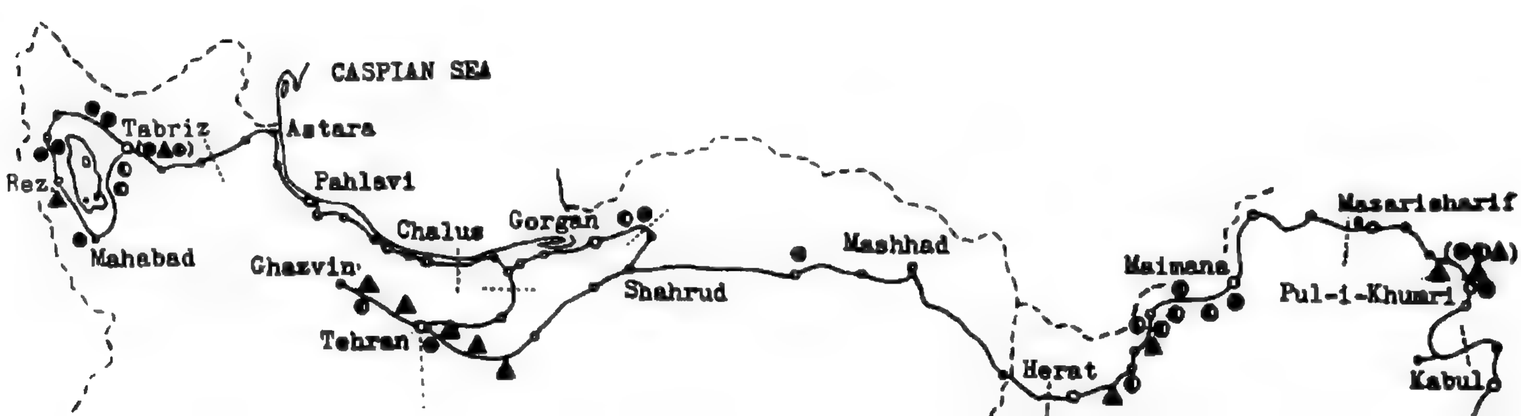
(iii) Growing habit

Sixty-five strains collected in 33 habitats from the different regions have been studied for growing habits in the experiment field in Kyoto. The results are given in Table 44 and Fig. 27. They were classified into 29 spring-types, 23 intermediate-

Table 44. Distribution of winter-, intermediate- and spring-types in *Ae. triuncialis*

Region and variety	Number of strains: winter	Number of strains: intermediate*	Number of strains: spring	Total
Pul-i-Khumri:				
typica	2	3	6	11
Maimana:				
persica	0	5	1	6
assyriaca	1	10	2	13
Tehran:				
typica	2	2	18	22
Gorgan:				
typica	1	1	0	2
Tabriz:				
typica	7	2	2	11
Total				
typica	12	8	26	} 65
persica + *assyriaca*	1	15	3	

* Intermediate-type in this case is closer to spring-type than to winter-type.



types, and 13 winter-types. Eighteen out of 22 strains from the Tehran region were perfect spring-types, and 18 out of 19 strains from the Maimana region were intermediate- or spring-types, while, seven out of 11 strains from the Tabriz region were winter-types.

However, mixed populations of spring- and winter-types were found near Tabriz in the Tabriz region and also near Haibak in the Pul-i-Khumri region. In this species also the spring-type might have arisen by a natural mutation from the winter-type.

d. Origin of ssp. *eu-triuncialis* EIG and ssp. *orientalis* EIG

The origin of *Ae. triuncialis* presents one of the most puzzling problems. Ssp. *eu-triuncialis* is represented by var. *typica*, and ssp. *orientalis* by var. *persica*. Ssp. *orientalis* is distinguished eventually by the characteristics such as barrel type disarticulation and awnlessness of ear.

The studies of the karyotype of *Ae. triuncialis* were reported by SENJANINOVA-KORCZAGINA (1932), and CHENNAVEERAIAH (1960). SENJANINOVA-KORCZAGINA established *Ae. persica* as an independent species, based on her karyomorphological finding that var. *persica* had a karyotype composed of C^u-genome of *Ae. umbellulata* and C-genome of *Ae. caudata*, while ssp. *eu-triuncialis* had the karyotype composed of C^u-genome and one genome which is not identical with that of *Ae. caudata*.

According to CHENNAVEERAIAH, however, var. *persica* has one set of chromosomes which corresponds to the C^u-genome, and the second set resembles C-genome. In ssp. *eu-triuncialis* he found also one set of chromosomes corresponding to C^u-genome, but he thought that the second set resembles not only the typical C-genome of *Ae. caudata*, but also that of var. *persica*. Therefore, he concluded that there are C^u and C in the *triuncialis* complex. ZOHARY and FELDMAN (1962) explained that the barrel type disarticulation in a form of var. *persica* is an introgression from *Ae. crassa*.

KIHARA and KONDO (1943) succeeded in synthesizing *Ae. triuncialis* as an amphidiploid CCC^uC^u, from *caudata* × *umbellulata*, which resembled var. *typica* morphologically. They found also that the ears of the synthesized one (*caudata* ×

4. *Aegilops cylindrica* Host (2n=28, genome symbol CCDD)

a. Collected materials and geographical distribution

As shown in Table 45, 34 strains of *Ae. cylindrica* were collected in 23 habitats in Iran, but none in Afghanistan.

Ae. cylindrica was known by BMUK (1959) to occur in Ankara in Turkey, being probably the western limit of its distribution. This species was not found either in Syria or in the western part of Turkey.

From the distribution of *Ae. caudata* and *Ae. squarrosa*, which were presumed to be the ancestors of *Ae. cylindrica* (Kihara 1941, 1944, McFadden and Sears 1946), the place where this species arose, could be thought to be in the eastern part of Turkey or in the Tabriz region.

According to Eig (1929), *Ae. cylindrica* involves two varieties, viz. *typica* Host and *pauciaristata* Eig, the former being an awned form and the latter an awnless or sparsely awned form. Var. *typica* was found in almost all habitats.

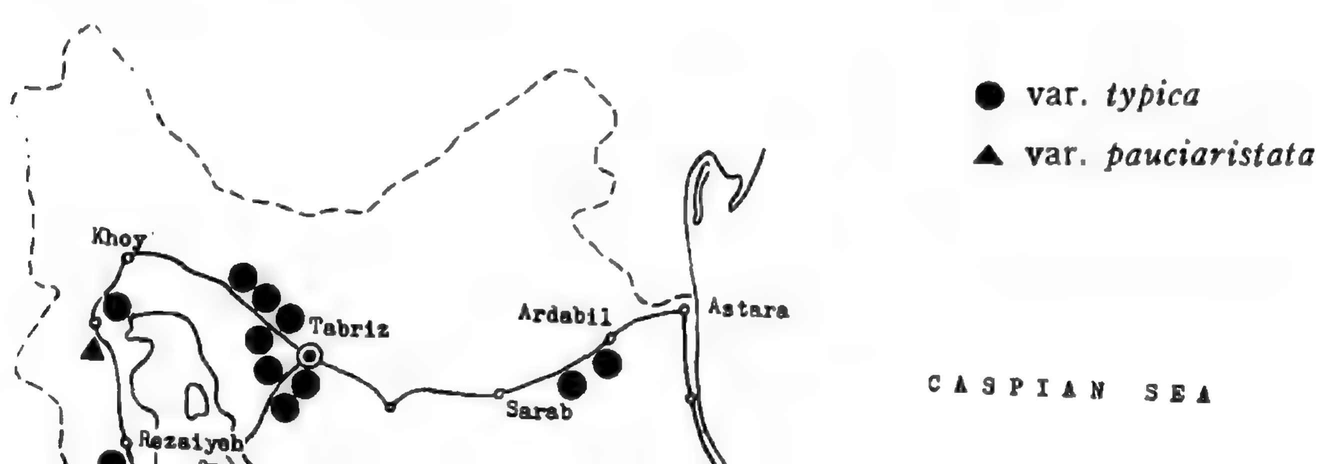
Table 45. List of *Ae. cylindrica* Host collected in Iran

Stock No.	Variety	Locality or source		Collector[1)]
2401-1	var. *typica* Host	Ghazvin,	Iran	K
2405-4	〃	〃	〃	〃
2406-4	〃	〃	〃	〃
2409-2	〃	Tehran – Karaj,	〃	〃
2410-2	〃	〃	〃	〃
2414-1	〃	〃	〃	〃
2416-1	〃	Tehran,	〃	〃
2417-1, -3	〃	Ardabil,	〃	〃
2418-1	〃	Ardabil – Sarab,	〃	〃
2420-2	〃	Tabriz,	〃	〃
2424-2	〃	〃	〃	〃

Table 45. (Continued)

2434–4	var. *typica* HOST	Mahabad – Rezaiyeh,	Iran	K
2435–3	〃	Rezaiyeh,	〃	〃
2436–2	var. *pauciaristata* EIG	Rezaiyeh – Khoy,	〃	〃
2438–1, –3	var. *typica* HOST	〃	〃	〃
2440–1	〃	〃	〃	〃
2441–8	〃	Khoy – Tabriz,	〃	〃
2442–2	〃	〃	〃	〃
2443–2	〃	〃	〃	〃
2444–2	〃	〃	〃	〃
2446–2	〃	〃	〃	〃
2447–1	〃	Rasht – Pahlavi,	〃	〃
2449–1	〃	〃	〃	〃
2450–14	〃	Mixed in chicken feed in Tabriz,	〃	Y
2454–1	〃	Collection of Agr. Exp. Sta., Tehran,	〃	
2455–1	〃	〃	〃	
2456–1	〃	〃	〃	
2457–1	〃	〃	〃	

1) K : H. KIHARA, Y : K. YAMASHITA.



Along the highway from Mahabad to Khoy, var. *pauciaristata* was found in a majority, as shown in Fig. 28. But by BMUK (1959), these two forms were found mixed in a population or separetely in the neighboring populations. The intermediate types were also found occasionally.

b. Morphological and physiological characters

Thirty-four strains collected from 23 habitats were observed for morphological and physiological variations; they are seven strains from the Tehran region, four strains from the Pahlavi region, ten strains from the eastern Tabriz region (Khoy – Tabriz – Mahabad), eight strains from the western Tabriz region (Khoy – Rezaiyeh – Mahabad), one strain mixed in chicken feed obtained in Tabriz, and four strains in collection of Agricultural Experiment Station in Tehran, Iran.

(i) Ear type

Two types have been known, namely an awned type and an awnless or sparsely awned type, as divided into two varieties by EIG (1929). These two types were found in Iran. But any intermediate type between these two types was not found. One strain (No. 2447) collected in Rasht – Pahlavi had a considerably long thick ear with long awn on the apical spikelet compared with other strains. In general the awn of the outer glume was longer than that of the empty glume, but some strains with long awn of the empty glume were also found (Fig. 29).

(ii) Plant height and tillering habit

A difference in culm height between the strains from different regions was not found, as shown in Table 46.

Almost all strains exhibited the erect habit, but two strains (Nos. 2441 and 2442) collected in Khoy – Tabriz had the procumbent habit.

(iii) Flowering date

No particular difference between the strains from different regions was found, though there was a slight tendency toward early flowering in the western Tabriz region, as shown in Table 47.

(iv) Seed-fertility

Difference in seed-fertilities between the samples from the original habitats in 1955 and those from the cultivation in the experiment field in Kyoto in 1956 are shown in Table 48. This suggests that the seed-fertility of this species is

a. var. *typica*,

b. var. *pauciaristata*,

c. New strain having short awn of outer glume on the apical spikelet

Fig. 29. Ear type of *Ae. cylindrica*

Table 46. Variation in plant height in *Ae. cylindrica* collected in Iran

Locality or source (variety)	Number of strains with the height		
	~50 cm	~60 cm	~70 cm
Tehran (*typica*)	1	4	2

Table 47. Frequency of early and late flowering strains of *Ae. cyrindrica* collected in Iran (Observed in Kyoto, 1956)

Locality or source (variety)	Number of strains with the flowering date		
	~17/V	~22/V	~27/V
Tehran (*typica*)	0	7	0
Pahlavi (*typica*)	0	2	2
Eastern Tabriz (*typica*)	0	6	4
Western Tabriz (*typica*)	2	0	2
Western Tabriz (*pauciaristata*)	2	2	0
Mixed in chicken feed (*typica*)	0	1	0
Agr. Exp. Sta., Tehran (*typica*)	1	0	3
Total	5	18	11

Table 48. Comparison of seed-fertility between materials from the original habitat (1955) and those from the experiment field in Kyoto (1956), in *Ae. cylindrica*

Material	Seed-fertility				
	~20%	~40%	~60%	~80%	~100%
Original habitat	1	6	18	22	5
Experiment field	2	7	36	5	0

5. *Aegilops columnaris* Zhuk. (2n=28, genome symbol $C^uC^uM^cM^c$)

a. Collected materials and geographical distribution

Based on the morphological studies 21 strains collected from four habitats in

Table 49. List of *Ae. columnaris* Zhuk. collected in Iran

Stock No.	Variety	Locality		Collector[1)]
2538-8	var. *glabriuscula* EIG	Ghazvin,	Iran	K
2539-3	〃	〃	〃	〃
2540-7	〃	〃	〃	〃
2542-1	〃	〃	〃	〃
2544-2	〃	〃	〃	〃
2545-5	〃	〃	〃	〃
2547-4	〃	〃	〃	〃
2551-2	var. *typica* ZHUK.	〃	〃	〃
2552-1	var. *glabriuscula* EIG	〃	〃	〃
2555-1	〃	〃	〃	〃
2558-1	〃	〃	〃	〃
2559-2	〃	〃	〃	〃
2560-4	〃	〃	〃	〃
2563-8	〃	〃	〃	〃
2564-2	〃	〃	〃	〃
2566-1	〃	〃	〃	〃
2570-10	var. *typica* ZHUK.	Karaj (Suburbs of Tehran),	〃	〃
2598-7	〃	Mahabad – Rezaiyeh,	〃	〃
2599-1	〃	〃	〃	〃
2603-1	〃	〃	〃	〃
2612-1	〃	Rezaiyeh – Khoy,	〃	〃

1) K : H. KIHARA.

Table 50. Number of strains and habitats of *Ae. columnaris* collected in Iran

a b c d

Fig. 30. Ears of *Ae. columnaris*

a, b. var. *glabriuscula* (a. No. 2542-1, b. No. 2558-1),
c, d. var. *typica* (c. No. 2551-2, d. No. 2598-7)

Those strains were crossed with *Ae. triuncialis* and with *Ae. columnaris* in our old collection for verifying the identification. The former hybrids revealed the meiotic figures, $(6\sim9)_{II}+(16\sim10)_{I}$ and were sterile, while the latter hybrids revealed 14_{II}, or $I_{IV}+12_{II}$ and were entirely fertile. These results suggest that those strains belong to *Ae. columnaris*.

In two hybrids among 10 combinations high percentage of PMC's with one

Table 51. Chromosome pairing of the hybrids between the collected strains and *Ae. columnaris* of old collection

Combination	Frequency of PMC's with	
	$1_{IV}+13_{I}$	14_{I}

tetravalent was observed, namely in No. 2570 × *Ae. columnaris* No. 1 and No. 2612 × *Ae. columnaris* No. 1 (Table 51). Accordingly it can be said that one reciprocal translocation is involved in two strains, Nos. 2570 and 2612.

According to EIG (1929), *Ae. columnaris* occupies a very limited area in Asia Minor. In the light of the present studies, however, it has been found that the distribution[1] of this species extends as far as the western and central part of Iran.

b. Morphological and physiological characters

Var. *glabriuscula* has glabrous glumes while var. *typica* has pubescent glumes, but other morphological differences were also found, namely Nos. 2538, 2544, 2555 and 2570 of the former variety exhibited denser, two rowed ear, while the latter variety had relatively wide spikelet and thick ear. Height of culm of var. *glabriuscula* was about 30∼40 cm, while that of var. *typica* was 40∼45 cm. But no difference was found in the flowering date between the two varieties.

Seed-fertilities of the samples from the original habitats in 1955 and those from cultivation in the experiment field in 1956 are given in Table 52. The noticeable difference between the two could be based on the difference in the environmental conditions between the original habitat and Kyoto, Japan, being the former arid and the latter rainy during the flowering time. In general this species seems to be sensitive to the enviromental conditions, and hence its distribution is extremely limited.

Table 52. Comparison of seed-fertility between material from the origianl habitat (1955) and those from the experiment field in Kyoto (1956), in *Ae. columnaris*

Material	Seed-fertility				
	∼20%	∼40%	∼60%	∼80%	∼100%
Original habitat	9	5	8	0	1
Experiment field	21	0	0	0	0

II. *Triticum*

The collections were classified into 300 strains (Appended Table 1), including four species, *T. durum*, *T. turgidum*, *T. vulgare* and *T. compactum*, collected from the fields and five species, *T. aegilopoides*, *T. polonicum*, *T. orientale*, *T. spelta* and *T. sphaerococcum*, obtained from various organizations.

1. Hexaploid species

For the classification of *T. vulgare* (*T. aestivum*) the systems of KÖRNICKE (1885) and MANSFELD (1951) were adopted. However, the continuous variations in the color of glume, awn and grains caused confusion in the practical application of those systems.

All the strains listed in Table 53 are maintained at the Research Institute for Agricultural plants, Faculty of Agriculture, Kyoto University, Kyoto, Japan.

a. Morphological and physiological characters and their distributions in *T. vulgare* VILL. and *T. compactum* HOST

Four principal characters, namely awn length, empty glume hairiness and color and seed color, and also earliness shown by the flowering date were observed for 281 strains of *T. vulgare* and *T. compactum* (Tables 53, 54).

a) Awn length: As shown in Table 53, long-awned strains occurred in a majority in almost all regions, except for the Isfahan and Tehran regions. Many short-awned or awnless strains were found in the Isfahan, Tehran, Quetta and Kabul regions.

b) Empty glume hairiness: As shown in Table 53, strains with glabrous glume predominated numerically in almost all regions, except for the Maimana and Tabriz regions. In the Gorgan and Pul-i-Khumri regions. only the glabrous type was found.

c) Empty glume color: As given in Table 53, two types, brown and yellow, were found in all regions. The proportions varied in different regions. Brown dominated over yellow in the Tehran and Maimana regions. In other regions, yellow predominated.

d) Seed color: As seen in Table 53, brown dominated over yellow, in almost

Table 53. Geographical distribution of the principal morphological characters of *T. vulgare*

Region	Awn			Glume hairiness		Spikelet color		Seed color	
	long	short	awnless	pubes-cent	glabrous	brown	yellow	brown	yellow
Pakistan :									
Quetta	16	1	8	7	18	8	17	15	10
Afghanistan :									
Kabul	36	18	0	18	36	23	31	31	23
Pul-i-Khumri	2	0	0	0	2	2	0	1	1
Maimana	8	3	0	8	3	9	2	5	6
Iran :									
Tehran	39	28	2	24	45	49	20	37	32
Isfahan	6	15	15	17	19	10	26	22	14
Gorgan	18	0	0	0	18	4	14	18	0
Pahlavi	40	0	0	11	29	20	20	30	10
Tabriz	24	0	2	16	10	7	19	17	9
Total	189	65	27	101	180	132	149	176	105

Table 54. Frequency of early and late flowering strains obtained from nine regions in *T. vulgare*

Region	Flowering date observed in Kyoto, 1956									Total
	~5/V	~10/V	~15/V	~20/V	~25/V	~30/V	~5/VI	~10/VI	~15/VI	
Pakistan :										
Quetta	1	8	9	5	2					25
Afghanistan :										
Kabul		7	9	13	10	13	1		1	54
Pul-i-Khumri					2					2
Maimana			1	1	3	4	2			11
Iran :										
Tehran		1		2	31	34	1			69
Isfahan					22	14				36

Table 55. Geographical distribution of four principal characters in *T. vulgare*

Combination of characters				Region									Total
Awns	Glume	Spikelet	Seed	Quetta	Kabul	Pul-i-Kh.	Maimana	Tehran	Isfahan	Gorgan	Pahlavi	Tabriz	
long	pubescent	brown	brown	1	4	0	0	4	0	0	2	1	12
〃	〃	〃	yellow	0	1	0	4	2	0	0	0	0	7
〃	〃	yellow	brown	2	3	0	0	4	2	0	3	5	19
〃	〃	〃	yellow	2	3	0	1	1	1	0	6	8	22
〃	glabrous	brown	brown	1	12	1	1	7	0	4	14	5	45
〃	〃	〃	yellow	5	1	1	1	9	0	0	4	0	21
〃	〃	yellow	brown	2	6	0	1	7	3	14	11	5	49
〃	〃	〃	yellow	3	6	0	0	5	0	0	0	0	14
short	pubescent	brown	brown	0	0	0	3	5	3	0	0	0	11
〃	〃	〃	yellow	0	1	0	0	7	2	0	0	0	10
〃	〃	yellow	brown	0	0	0	0	0	0	0	0	0	0
〃	〃	〃	yellow	0	6	0	0	0	0	0	0	0	6
〃	glabrous	brown	brown	0	2	0	0	7	4	0	0	0	13
〃	〃	〃	yellow	1	2	0	0	6	0	0	0	0	9
〃	〃	yellow	brown	0	4	0	0	3	4	0	0	0	11
〃	〃	〃	yellow	0	3	0	0	0	2	0	0	0	5
awnless	pubescent	brown	brown	0	0	0	0	0	1	0	0	1	2
〃	〃	〃	yellow	0	0	0	0	1	0	0	0	0	1
〃	〃	yellow	brown	2	0	0	0	0	1	0	0	1	4
〃	〃	〃	yellow	0	0	0	0	0	7	0	0	0	7
〃	glabrous	brown	brown	0	0	0	0	0	0	0	0	0	0
〃	〃	〃	yellow	0	0	0	0	1	0	0	0	0	1
〃	〃	yellow	brown	6	0	0	0	0	3	0	0	0	9
〃	〃	〃	yellow	0	0	0	0	0	3	0	0	0	3
Total				25	54	2	11	69	36	18	40	26	281

b. Distribution of varieties of *T. vulgare* VILL. and *T. compactum* HOST

Varieties of *T. vulgare* and *T. compactum* and their frequencies are given in Table 56.

Table 56. List of varieties of *T. vulgare* and *T. compactum* in nine regions in Paksitan, Afghanistan and Iran and their frequencies

Variety	Quetta	Kabul	Pul-i-Kh.	Maimana	Tehran	Isfahan	Gorgan	Pahlavi	Tabriz	Total
T. vulgare VILL.										
Normal glume group–										
long awned:										
var. *barbarossa*	(1)	2			3			2	1	9
var. *barbarossa-compactoides*		2								2
var. *turcicum*				4	2					6
var. *turcicum-compactoides*		1								1
var. *hostianum*		1			2	1		1	4	9
var. *hostianum-compactoides*	(2)	2				1				5
var. *murinum*					1					1
var. *meridionale*	(2)	2			1			6	8	19
var. *meridionale-compactoides*		1						1		2
var. *griseum*				1						1
var. *nigromeridionale*						1				1
〃 with brown grains (*nova*)								1	1	2
var. *ferrugineum*	(1)	9	1		6		4	8	5	34
var. *ferrugineum-compactoides*				1	1			4		6
var. *erythroleucon*	2+(1)	1	1	1	[illegible]			[illegible]		17

Table 56. (Contiuned)

short awned:											
var. *subrubromurinum*						2					2
var. *subturcicum*		1									1
var. *subnigroturcicum*						1					1
var. *submeridionale*		4									4
var. *subferrugineum*		3			1+(1)	1					6
var. *subferrugineum-compactoides*		1			1	2					4
var. *suberythroleucon*	(1)										1
var. *suberythroleucon-compactoides*					3						3
var. *suberythrospermum*		4			1	2					7
var. *subgraecum*		3				3					6
awnless:											
var. *nigrocyanorubrum*									1		1
var. *velutinum*									1		1
var. *velutinum-compactoides*	(2)										2
var. *lutescens-compactoides*	(5)										5
Inflated glume group–											
long awned:											
var. *echinodesinflatum*, with lax ear (*nova*)					1						1
short awned:											
var. *subbarbarossa-inflatum*				3	4+(1)						8
var. 〃, with yellow grains (*nova*)					7	1					8
var. *subechinodes-inflatum*						1					1
var. *submeridional-inflatum*		2									2
var. *subferrugineum-inflatum*					4	1					5
var. *suberythroleucon-inflatum*					3						3

Table 56. (Continued)

var. ***khorossanicum***						6				6
var. ***lutinflatum***	1					4				5
var. ***albinflatum***						2				2
T. compactum HOST										
var. ***erinaceum***		3						3		6
Total	25	54	2	11	69	36	18	40	26	281

Strains in ( ) were provided by the courtesy of the Department of Agriculture, or of Agricultural Experiment Station.

c. Description of varieties of *T. vulgare* VILL.

1. Normal glume group

Race 1. Awn long, empty glume pubescent and brown, seed brown.

a) The type with lax ear can be referred to as var. ***barbarossa*** ALEF. from Asia. This variety was found in three neighboring regions, Tehran, Pahlavi, and Tabriz and also in the Kabul region (Fig. 31a).

b) The type with somewhat dense ear can be referred to as var. ***barbarossa-compactoides*** GÖKG. from Asia Minor.. This variety was found only in the Kabul region (Fig. 31b).

Race 2. Awn long, empty glume pubescent and brown, seed yellow.

a) The type with lax ear can be referred to as var. ***turcicum*** KÖRN. from Caucasus, Asia Minor, etc.. This variety was found in the Maimana and Tehran regions (Fig. 31c).

b) The type with somewhat dense ear can be referred to as var. ***turcicum-compactoides*** ZHUK. from Asia Minor. This variety was found only in one habitat in the Kabul region (Fig. 31d).

Race 3. Awn long, empty glume pubescent and yellow or grey, seed brown.

a) The type with lax ear and yellow glume can be referred to as var. *hostianum* KÖRN.. This variety was found mainly in Iran (Fig. 32a).

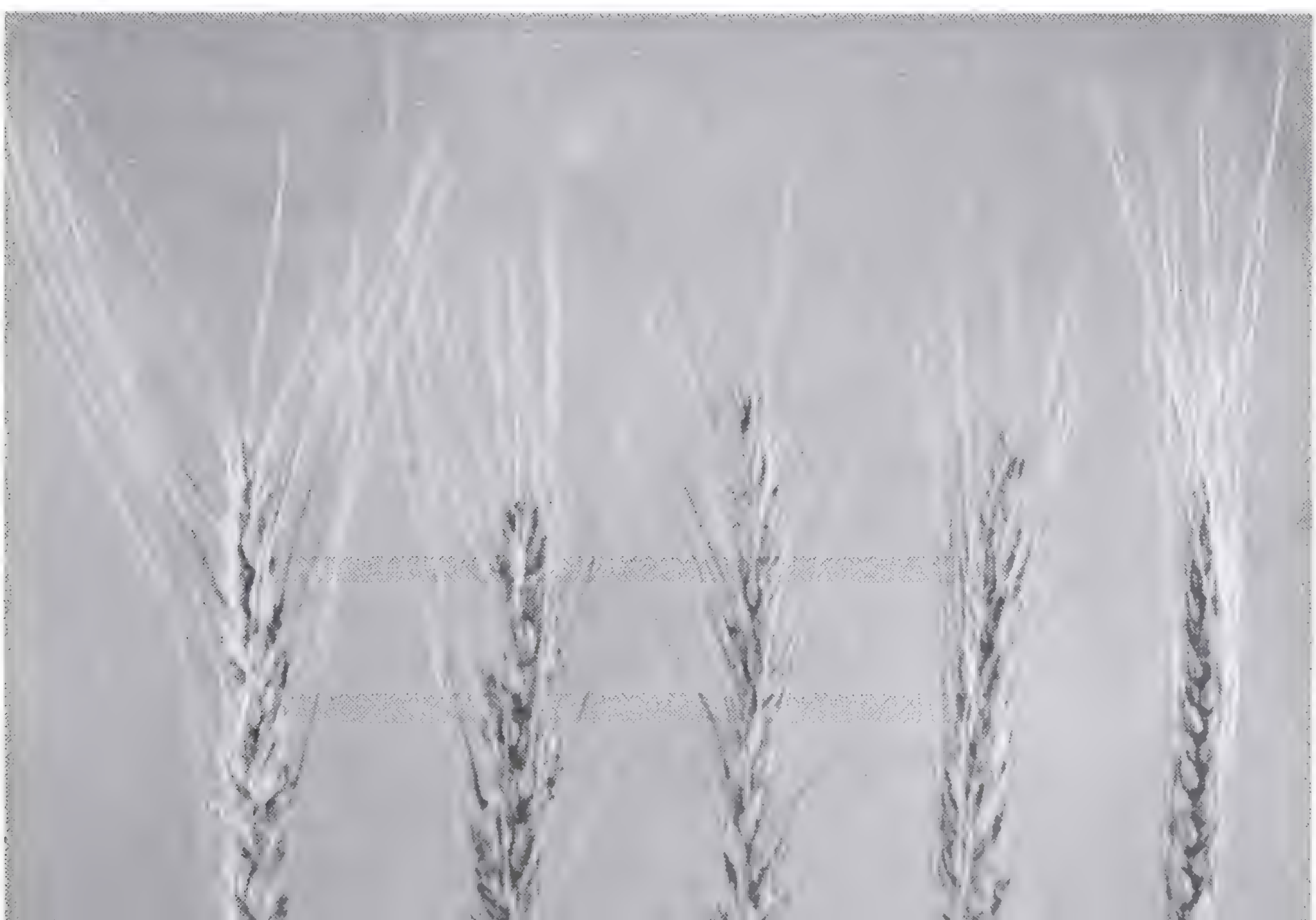
b) The type with somewhat dense ear and yellow glume can be referred to as var. *hostianum-compactoides* GÖKG. from Europe. This variety was found mainly in the Kabul region (Fig. 32b).

c) The type with lax ear and grey glume can be referred to as var. *murinum* FLAKSB. from Iran, India and others. This variety was found only in Mashhad - Shahrud, in Iran (Fig. 32c).

Race 4. Awn long, empty glume pubescent and yellow or grey, seed yellow.

a) The type with lax ear and yellow glume can be referred to as var. *meridionale* KÖRN. from Europe. A large number of this variety was found mainly in the Pahlavi and Tabriz regions (Fig. 33a).

b) The type with somewhat dense ear and yellow glume can be referred to as var. *meridionale-compactoides* GÖKG. from Asia Minor. This variety was found sparsely in the Kabul and Pahlavi regions (Fig. 33b).



c) The type with lax ear and grey glume can be referred to as var. ***griseum*** VAV.. This variety was found only in one habitat in the Maimana region (Fig. 33c).

d) The type with lax and black spots can be referred to as var. ***nigromeridionale*** GÖKG.. This variety was found only in Isfahan (Fig. 33d).

However a new type with brown colored grains was found in two neighboring habitats, namely Tabriz and Ardabil, in Iran (Fig. 33e).

Race 5. Awn long, empty glume gabrous and brown, seed brown.

a) The type with lax ear can be referred to as var. ***ferrugineum*** ALEF.. This variety was found abundantly in almost all regions, except Isfahan and Maimana (Fig. 34a).

b) The type with somewhat dense ear can be referred to as var. ***ferrugineum-compactoides*** KOB. from Asia Minor. This variety was found mainly in the mountainous districts of Ardabil (Astara-Tabriz) in the Pahlavi region in Iran.

The type with short and dense ear can be referred to as *T. compactum* HOST var. ***erinaceum*** KÖRN.. Two types, one with long somewhat dense ear and the other with short dense ear, were found to grow mixed in the common population (Fig. 34b).

Race 6. Awn long, empty glume glabrous and brown, seed yellow.

a) The type with lax ear can be referred to as var. ***erythroleucon*** KÖRN.. This variety was found mainly in the Tehran and Pahlavi regions (Fig. 34c).

b) The type with somewhat dense ear can be referred to as var. ***erythroleucon-compactoides*** KOB.. This variety was found sparsely in the Quetta and Tehran regions (Fig. 34d).

Race 7. Awn long, empty glume glabrous and yellow or grey, seed brown.

a) The type with lax ear and yellow glume can be referred to as var. ***erythrospermum*** KÖRN.. This variety was found abundantly in almost all regions, especially in the area around the Elburz Mountains in the Gorgan, Tehran and Pahlavi regions (Fig. 35a).

b) The type with somewhat dense ear and yellow glume can be referred to as var. ***erythrospermum-compactoides*** Kob. from Asia Minor. This variety was found mainly in the Kabul, Gorgan and Pahlavi regions (Fig. 35b).

c) The type with lax ear and grey glume can be referred to as var. ***fulvo-cinereum*** Flaksb.. This variety was found in two habitats in the Pahlavi region (Fig. 35c).

Race 8. Awn long, empty glume glabrous and yellow, seed yellow.

a) The type with lax ear can be referred to as var. ***graecum*** Körn.. This variety was found in the Quetta, Kabul and Tehran regions (Fig. 35d).

b) The type with somewhat dense ear can be referred to as var. ***graecum-compactoides*** Kob. from Asia Minor. This variety was found in the Kabul and Tehran regions (Fig. 35e).

Race 9. Ear lax, awn short, empty glume pubescent and grey, seed brown.

This race can be referred to as var. ***subrubromurinum*** Gökg. from Asia Minor. This variety was found only in one habitat in the Isfahan region (Fig. 36a).

Race 10. Ear lax, awn short, empty glume pubescent and brown, seed yellow.

a) This type can be referred to as var. ***subturcicum*** VAV. from Iran (Fig. 36b).

b) The type with black spots can be referred to as var. ***subnigroturcicum*** GÖKG. from Asia Minor. These two varieties were found in the Kabul and Isfahan regions, respectively (Fig. 36c).

Race 11. Ear lax, awn short, empty glume pubescent and yellow, seed yellow.

This race can be referred to as var. ***submeridionale*** VAV. from Iran, Afghanistan and Asia Minor. This variety was found only in the southern Kabul region (Fig. 36d).

Race 12. Awn short, empty glume glabrous and brown, seed brown.

a) The type with lax ear can be referred to as var. ***subferrugineum*** VAV. from Turkestan, Iran and others (Fig. 37a).

b) The type with somewhat dense ear can be referred to as var. ***subferrugineum-compactoides*** GÖKG.. These two varieties were found in the same habitats in the Isfahan, Tehran and Kabul regions (Fig. 37b).

Race 13. Awn short, empty glume glabrous and brown, seed yellow.

a) The type with lax ear can be referred to as var. ***suberythroleucon*** VAV. from Iran, Mongolia, China and others. This variety was obtained from the Agricultural Experiment Station in Quetta (Fig. 37c).

b) The type with somewhat dense ear can be referred to as var. ***suberythro-leucon-compactoides*** GÖKG. from Asia Minor. This variety was found only in two isolated habitats in the Tehran region (Fig. 37d).

Race 14. Ear lax, awn short, empty glume glabrous and yellow, seed brown or yellow.

a) The type with brown seed can be referred to as var. ***suberythrospermum*** VAV. from Iran and others. This variety was found in three regions, namely Kabul, Tehran and Isfahan (Fig. 38a).

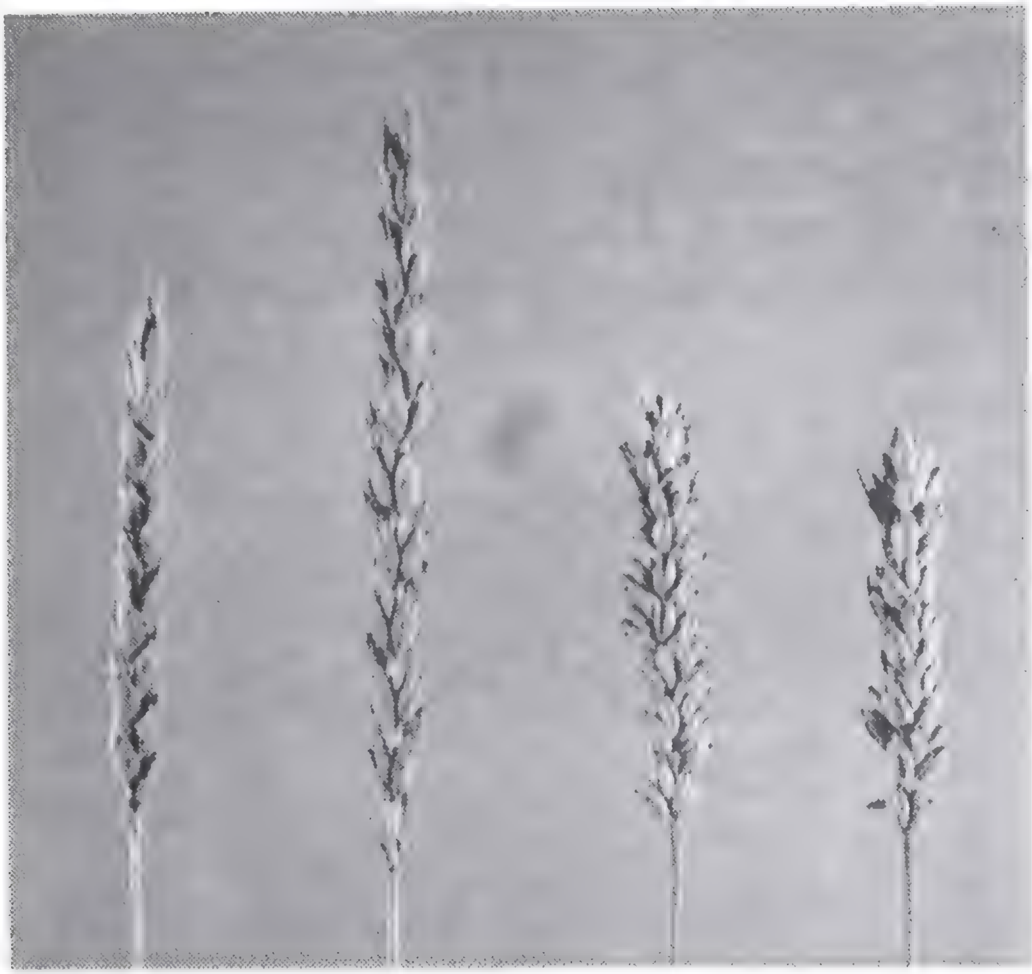
b) The type with yellow seed can be referred to as var. ***subgraecum*** VAV. from Turkestan. This variety was found in two isolated regions, namely Kabul and Isfahan (Fig. 38b).

a b

Fig. 38. *T. vulgare*

a. var. ***suberythrospermum*** (No. 3053-1),
b. var. ***subgrecum*** (No. 3166-10)

b) The type with somewhat dense ear can be referred to as var. ***velutinum-compactoides*** ZHUK. from Asia Minor. This variety was obtained from the Agricultural Experiment Station in Quetta (Fig. 39c).



a b c d

Fig 39. *T. vulgare*

a. var. ***nigrocyanorubrum*** (No. 3355–3), b. var. ***velutinum*** (No. 3362–10), c. var. ***velutinum-compactoides*** (No. 3048–1), d. var. ***lutescens-compactoides*** (No. 3045–2)

Race 17. Ear somewhat dense, awnless, empty glume glabrous and yellow, seed brown.

This race can be referred to as var. *lutescens-compactoides* KOB. from Asia Minor. This variety was obtained from the Agricultural Experiment Station in Quetta (Fig. 39d).

2. Inflated glume group.

Errata I

(Minor typographical errors are not mentioned here.) KUSE Vol. I. 1965

Page	Position	Correction
9	Bottom	Read "are" for "is".
22	Line 14	Read "seriously" for "serionsly".
92	Fig. 45, c	Read "*muriciense*" for "*murciense*".
92	Line 2	Read "Firuzkuh" for "Furuzkuh"
109	App. Tab. 1, line 5	Read "yellow grains" for "yellow giains".
113	App. Tab. 1, line 15	Read "*muriciense*" for "*murciense*".
144	Fig. 1	Read "Locality" for "Loeality".
147	Line 16	Read "majority" for "the many".
155	Line 12	Read "hairless" for "hairy".
174	Line 26	Read "16" for "60".
189	Line 6	Read "color of" for "color, of".
191	Summary, line 6	Read "strains of" for "strain or".
200	Line 13	Read "are" for "is".
201	Line 3	Read "1909" for "1906".
212	Line 8	Read "veins" for "veines".
219	Fig. 10, e	Read "*piriformis*" for "*pririoform*".
222	Conclusion, line 20	Read "*foetidissima*" for "*foetidtssima*".
228	Tab. 3, line 27	Read "vines (%)$^{2)}$" for "vines$^{2)}$".
231	Line 4	Read "remarkably" for "remarkbly".
238	Tab. 2, line 13	Read "28" for "2.8".
239	Tab. 2, line 14	Read "2.0" for "20".
254	Line 5	Read "five" for "ufive".
259	Line 7 from bottom	Read "HCl" for "HCL".
260	Fig. 1, a	Read "$(CH_2)_4$" for "CH_{24}".
261	Line 12	Read "730mμ" for "730mu"
261	Line 13 from bottom	Read "morphological" for "mophological"

Errata II

(Minor typographical errors are not mentioned here.) KUSE Vol. I. 1965

Page	Position	Correction
304	Photo. 15, bottom	Read "arrives" for "arrive".
319	April 18, line 2	Read "Chillinji Pass" for "Chiringa Pass".
319	April 21, line 5	Read "Kar Gah Valley" for "Kalga Valley".
319	April 22, line 2	Read "Thelichi" for "Tarichi".
319~20	Bottom~top	Cross out "and the Kobando in the other".
320	Line 1	Read "Bilchhar Dobani" for "Birucharu Dobando".
326	June 19, line 3	Read "explorers" for "explorer".
329	July 3, line 3	Read "were" for "was".
337	July 8, line 1	Read "Charsadda" for "Chalsada".
337	July 16, line 2	Read "LANDAUER" for "RANDAUER".
338	July 24, line 5	Read "LANDAUER" for "RANDAUER".

RESULTS OF THE KYOTO UNIVERSITY
SCIENTIFIC EXPEDITION
TO THE KARAKORAM AND HINDUKUSH, 1955, Vol. I

CULTIVATED PLANTS AND THEIR RELATIVES

Edited by
KOSUKE YAMASHITA

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EDITORIAL NOTE

The publications of the results of the Kyoto University Scientific Expedition to the Karakoram and Hindukush, 1955, are completed in the following eight volumes:

I. Cultivated Plants and Their Relatives. Ed. by K. YAMASHITA
II. Flora of Afghanistan. Ed. by S. KITAMURA
III. Plants of West Pakistan and Afghanistan. Ed. by S. KITAMURA
IV. Insect Fauna of Afghanistan and Hindukush. Ed. by M. UÉNO
V. Personality and Health in Hunza Valley. Ed. by K. IMANISHI
VI. Zirni Manuscript. Ed. by S. IWAMURA
VII. Geology of Karakoram and Hindukush. Ed. by S. MATSUSHITA
VIII. Additional Reports. Ed. by S. KITAMURA and R. YOSII.

Vols. II～VII have already been published. The present Volume contains (1) the results of the investigations on cultivated plants and their relatives collected from Pakistan, Afghanistan and Iran (2) photographs and (3) itineraries.

The present Volume has been published with the help of the Fauna and Flora Research Society, Kyoto University with financial assistance from the Asahi Press.

Kyoto, Japan
October 31, 1965

A. O.

PREFACE

Since its establishment in 1951, the Fauna and Flora Research Society (FFRS) of Kyoto University has been always quite active. The expeditions organized by FFRS were sent to Nepal in the years 1952 and 1953. The scientific results were published in three volumes edited by myself:

I. Fauna and Flora of Nepal Himalaya, 1955

II. Land and Crops of Nepal Himalaya, 1956

III. Peoples of Nepal Himalaya, 1957

Many of the authors of these publications are members of FFRS. They have studied the materials brought from Nepal by the parties. With the progress of their investigations, they became more and more interested in the fauna, flora and also peoples around the Himalayan mountain ranges.

As I have mentioned in my preface to "Fauna and Flora of Nepal Himalaya", FFRS is closely affiliated with the Academic Alpine Club of Kyoto University (AACK). Many of us are members of both societies. Therefore there is no wonder that the projects were directed to high mountain ranges. K2 of Karakoram had been once the object of AACK. Accordingly, the members of FFRS have unanimously agreed to organize a scientific expedition to Karakoram, though the object of the party was not climbing high mountains. There are many peaks 8,000 meters high above sea-level and big glaciers which attract not only mountaineers but also geologists. Also there are peoples, with whom we were not familiar. Especially we have been curious whether it is true or not, that Hunza Valley is a Utopia, as all inhabitants seem to be there free from diseases. Sensational articles about this paradise appeared in many magazines and even in scientific books. Dr. IMANISHI, who started his carrier as entomologist and specialized later in anthropology, is a member of both FFRS and AACK. He showed a special interest in traveling and collecting anthropological materials together with his colleagues in Karakoram. Prof. MATSUSHITA, a geologist, and his assistant, accompanied him for geological surveys.

We found also reasons to include Hindukush into the area of our exploration. In 1954, Prof. IWAMURA went to Afghanistan. He was interested in the Moghol

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